ECONOMICS OF ENGINEERING

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BY

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ECONOMICS OF ENGINEERING.

WORKS BY PROF. B. C. CHATTERJEE.

The Elements of Applied Electricity:—

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Notes on Building & Building Materials. Rs. 3.

PREFACE.

This book is founded on the lectures in Engineering Economics delivered yearly to the Graduate class in Engineering of the Benares Hindu University. Its title is justified by the fact that it is chiefly concerned with the Economics of Mechanical and Electrical Engineering, but it includes a great deal that does not fairly come under that heading. There is, for example, a chapter on Law which it is hoped may be of material assistance to those who contemplate launching a new Enterprise; especially in the initial phase. It is an attempt to make the instruction given to Engineering students more practical in the business sense than has hitherto been customary in Engineering colleges. A good deal of it will no doubt appear rather elementary and obvious to the practised business man, unaware as he is of the way in which his pre-occupation with technical problems causes the young engineer to grow up very unfit to manage his own money matters, and, of course, still more unfit to manage those of his employer. This deficiency of the engineer student as usually educated, is beginning to be recognized in England. Several institutions having within the last year or two added Engineering Economics to their lists of examinations. The present work, however does not follow any of these syllabusses very closely. The most conspicuous variation is that the authors of this book

have principally concerned themselves with Indian conditions and have given less attention to world trading.

For many years, perhaps generations to come, the conditions which the young engineer in India must face will continue to differ materially from those which confront his English confrere. The principal difference is that specialisation can safely be developed much more in England or America than is expedient here. An English student may safely devote all his youth to becoming expert in any one of a number of small branches with a reasonable prospect of securing employment in some great firm which can afford the services of many such. Such a man would be almost useless in any of those mafussalite stations in which most Indian students must expect their future. There would be little scope for his advanced special knowledge, and the ignorance of other matters which must necessarily follow from his intense concentration on a particular aspect of Engineering would be a fatal handicap. The young Indian who professes a knowledge of Mechanical Engineering must also be able to cope with all but abnormal difficulties in Electrical Engineering, and he who professes Electrical Engineering would be quite useless to his employer if he were afraid of his engine and boiler. Moreover, both should be able to undertake many jobs that in the West would be entrusted to a Civil Engineer or to an Architect. Finally every young engineer in this country should be as good a business man as it is possible to become without a prolonged experience of the world at large.

It is this last requirement that we have endeavoured to satisfy in this volume. In the first part certain fundamental economic principles are explained. In the second a good deal of space is devoted to ordinary business procedure which many people will think would be more fittingly taught in a secondary school. That is also our own opinion, but we cannot afford to leave our students ignorant in the matter until it is. In the third part the Economics of Mechanical and Electrical Engineering is specially dealt with. No endeavour has been made to cater for the Civil Engineer.

At the end of most of the chapters sundry extracts from the periodical press or from other books will be found. The authors have read many books, but they do not think it fair to suggest that other writers are responsible for the opinion they express on certain matters open to debate. Their own and others' opinions are offered as suggestive rather than conclusive. Their aim throughout is to direct the student's mind along certain fertile lines of thought. He belongs presumably to the rising generation that must presently inherit all the world and its difficulties. Our aim is to make him aware of both the unsolved and the solved problems, and so launch him in the profession as a thinking member.

CONTENTS.

		PAGE
CHAPTER I.		
Money		1
CHAPTER II.		
Money in the Great World		21
CHAPTER III.		
Capital		28
CHAPTER IV.		
International Money		42
CHAPTER V.		
Trading Abroad and Transport	...	49
CHAPTER VI.		
Banks and Insurance Companies.	...	58
CHAPTER VII.		
The Ledger.		68
CHAPTER VIII.		
Auxiliary Books.		96
CHAPTER IX.		
Choice of a Factory Site, and Buildings.	...	109
CHAPTER X.		
Choice of a Source of Power.	...	130
CHAPTER XI.		
General Organisation of a Central Power Station.		160
CHAPTER XII.		
Depreciation and Valuation	...	189

CHAPTER XIII.

Jobbing and Mass Production ... 215

CHAPTER XIV.

Inquiries, Progress Cards 222

CHAPTER XV.

Workmen's Time Cards, Gate control. ... 228

CHAPTER XVI.

Depreciation, The Theory of over time, Machine cards. 233

CHAPTER XVII.

Stores, Tool Room, Raw Materials. ... 242

CHAPTER XVIII.

Over-head Charges, Cost Summary, Selling price. 250

CHAPTER XIX.

Trade cycle, and Economics of Mass production. 259

CHAPTER XX.

Organisation for Mass production. Choice of the article to be Manufactured. ... 265

CHAPTER XXI.

Contract and Specification. 276

CHAPTER XXII.

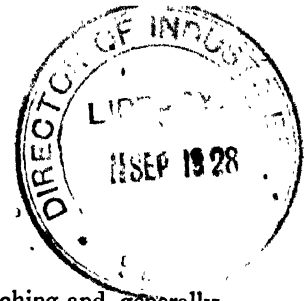
Laws affecting Engineer. 322

CHAPTER. XXIII.

Labour, Skill, and Capital. 377

ERRATA

Page	Line	For	Read
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11	19	todo	to do
16	5	Banks	banks
16	5	bank of	Bank of
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46	19	Euglish	English
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62	7	Palatial	Palacial
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70	21	R.s.	Rs
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96	2	Auxelliary	Auxiliary
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130	20	Moters	Motors
132	9	then	than
133	13	parts	ports
138	26	Poundage	Pondage
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210	In table	vaue	value
211	22	hy	by



CHAPTER I.

Money.

"Definition is a kind of scratching and generally leaves a sore place more sore than it was before" Samuel Butler's Note Book.

Let us suppose that about a dozen men are marooned on an island. One of these, Hira Lal, is a farmer, and in his new home continues to exercise that trade. A second is Munna Lal, a mistri and a third, Janaki Ram is a fisherman,—in the first instance. We shall see presently however, that Janaki Ram is a man of ideas, destined for greater things. The remainder are mere labourers and will be described collectively as "THE COOLIES".

Now Janaki Ram has discovered that once or twice a month after a storm, but at no other time, his nets contain a small number of rather beautiful shells and has treasured them till he has a collection of three thousand. Having done this, owing to some change in the oceanic currents, no more shells appear and the number remains three thousand. All the men in the island admire these shells very much and are willing to exchange what they can for them. Hira Lal gives cocoanuts, sugar cane, dahl and the like for them. Munna Lal builds quite a decent little house for Janaki Ram in return for three hundred shells, and after a time, finding

that a necklace of three hundred shells, with no one to admire it, is rather a nuisance than otherwise, hires the coolies to help him for a wage of one shell per day. The coolies would like to have necklaces for themselves but not being very skilful, they are generally compelled to exchange their shells for fish with Janaki Ram, or Dahl bhat with Hira Lal.

After a time, all the men on the island have more or fewer of these shells (The astute Janaki Ram more than any one else). They are "MONEY"—that particular form of money which is called "**Commodity money**" because they are not only of use as a medium of exchange, but have a certain value in themselves; as ornaments only in this case. Under other circumstances, other useful or ornamental articles may similarly come to be used as media of exchange. In South Africa among the natives, COWS ARE MONEY and it would appear that that was also the case in Vedic India, since in the Vedas the same words are used to signify both cattle and wealth. In primitive America, a delicate kind of LEATHER called wampum was the commodity money. In some parts of India at the present day SHELLS are still in use together with gold and silver which are the commodity money of most modern nations.

Prices.

It is or ought to be, evident that the price in shells of any thing or any service on the island depends on three things :—

(a) On the fact that the islanders have only three thousand shells among them, or as a pucca economist would say, on the quantity of 'money in circulation'.

(b) On "the effective demand" or in plain language, on how much those men who have shells to pay for it, want (not need) it.

The third thing on which prices depend is.

(c) "The supply" which is to say, on how much of it the others can spare.

These three are the only factors of price. The prices of things do not depend on :—

(a) Their utility. If they did, a loaf of bread would be more highly priced than a diamond, and water would be more expensive than wine.

(b) The amount of labour required to produce them. If they did, the work turned out by the First Year Students in the carpenter shop would be more valuable than that turned out by the Head Mistri, whereas it is of no more value than firewood after they have laboured on it for a week. Yet any one that cares to watch them can see that they work twice as hard as he does. It must not be too hastily assumed that his work is more valuable than theirs only because he is more skilful. The amount of skill expended has as little to do with prices as the amount of labour has. If both mistri and students made snow shoes their work would be equally vaueless. There is no effective demand for snowshoes in Benares.

Token money.

We have now to consider move number two of the resourceful Janaki Ram. Like most of us, he is very averse from digging up his shells, and rather more fertile in expedients for avoiding it. His scheme in this case is one that was first invented by the Emperor Khubla Khan about one thousand years ago.

On being asked to pay a debt he replies to his creditor somewhat on these lines ;—

"Achha Bhai ! But do you think you are wise to have so many shells lying about in your house ? Thos coolies—?

Are you sure, they wo'nt cut your only throat one of these dark nights ? Do'nt you think you had better leave your shells with me and take this nice little chit instead" The "nice little chit" is like this ;—

"I promise to pay the bearer ten shells on demand at my godown near the lagoon"

(Signed) Janaki Ram.

If the reader has a ten Ruppee currency note he should now take it out and look at it.

Now, absurd as it may seem at first sight, this game works not only on the island but has repeatedly workd under other circumstances all over the world. In a very short time, Janaki Ram has three thousand chits circulating on the island and has also lent the original three thousand shells at a substantial

interest to the very people to whom the shells really belong. He has invented the art of banking. He is by far the richest man on the island; greatly respected, and regarded as a public benefactor because he has doubled the price of everyone's produce, and doubled everyone's wages. All is joy till ;—

Inconvertible Currency.

Janaki Ram overdoes it. He sees no reason why he should stop at three thousand chits. When he has lent his three thousand shells he writes out as many more chits as he can find borrowers for. More inflation of the currency. An apparent profit of umpty percent for every one who has anything to sell. Big rises of salary and wages for every one. More glory for Janaki Ram !

But this is a risky game. We should say in the case of a modern nation that "It is off the gold basis" The promises on the chits could not be made good if all holders demanded payment in shells on the same day, which they would most certainly do if they inkled Janaki Ram's strategy. The turpitude of that Napoleon of commerce would become known to everyone. Not only would he be in a very awkward position, but the holders of the surplus chits (and also of the unsurplus ones on the principle of marginal values) would find that what they supposed to be real money was merely waste paper, and rather filthy waste paper at that. It is not only Janaki Ram therefore,

but also every one that has his chits, that is concerned to avoid the disclosure. Accordingly, as soon as Hira Lal and Munna Lal discover the imposture they declare the chits :—

Legal Tender.

There are very few chits (Bank notes. Currency notes) in the world now that have not long since been declared legal tender. Those who have resorted to this move have done so for substantially the reasons indicated in the above paragraph, but it is frequently represented as intended to "economise gold." The meaning of the phrase "LEGAL TENDER" is that a debt incurred is legally discharged if payment is made in chits (in legal tender). Before the chits were made legal tender, a creditor might demand payment in shells, but now he must take chits or shells, which ever is offered him. But whether the chit is legal tender or not, it is token money having no intrinsic value as commodity money has ; or, if, as is sometimes the case, it is made of an alloy of one of the precious metals, having a value in shells much less than it pretends to have.

Cheques.

The intelligent reader will have discoverd ere this that Janaki Ram's argument about the danger of theft was rather thin.

It is as easy to steal chits as it is to steal shells. A cheque is a chit (not issued by Janaki Ram, the banker but by one of the others who has deposited his shells in the bank) in this form :—

"Pay to Munna Lal or Order three hundred shells"
S 300-0-0 (SIGNED) HIRA LAL"

If Hira Lal has three hundred shells or more with Janaki Ram, the banker, and if Janaki Ram has not embezzled them, this is as good as money to Munna Lal, as soon as he signs his name on the back of it ("endorses it"). Until then Janaki will not give the shells and therefore it is of no use to any one that steals it. As it stands it is an "open cheque"; any one can cash it once Munna Lal has endorsed it. If "or Bearer" had been substituted for "on order" it might have been cashed even without endorsement.

Crossed Cheques.

If Hira Lal, before parting with the cheque had ruled two lines diagonally across it, writing, " & Co " between them, Janaki Ram would not have given cash for the cheque under any circumstances. He would only have recorded in his books that he now owed Hira Lal three hundred shells fewer and Munna Lal three hundred shells more. A crossed cheque is thus a very safe form in which to transmit money. It never leaves the bank in a spendable form at all, and therefore cannot be stolen except by thieves who are very expert indeed, and the really educated thief generally finds it more profitable and safer to operate within the law.

There are other forms of cheques, notably one called in this country a "HUNDI" and in others a "BILL". The

bill is described in the chapter on international money. At this stage it is sufficient to note that yet another "INFLATION" has taken place with its consequent results. The cheque, being the safest form of money is gradually replacing all other forms wherever large sums have to be transmitted through intermediaries, all over the world. As it can never be to everyone's advantage to declare it legal tender, it never is so declared.

Credit.

One would think that getting the islanders to accept worthless paper as the equivalent of shells had exhausted Janaki Ram's invention, but one would be mistaken. Most of the money in the world has no material existence at all. We are about to bid a long farewell to the island of Janaki Ram but before we do so we may watch that eminent financier establishing credit by the most usual method.

Coming home from a night's fishing very early one morning he is surprised to see a number of large tortoises burying their eggs in the only patch of sandy beach on the island. Now the particular part of the shore is the property of Munna Lal. It was assigned to him at the beginning because of a scheme he had for building and launching a boat there, but the scheme has never been carried out. The beach is supposed to be practically worthless. The greedy Janaki Ram might have it for a mere trifle in ready money, were

it not that he is burning to put into operation his third great idea which is :—

"If they accept paper on my promise why should they not accept the promise without the paper". There is another reason why he hesitates to issue any more chits. The others when they discovered that he had issued six thousand chits on the strengh of only three thousand shells, warned him very strictly that if he issued any more he would be boiled alive (There are similar laws limiting the ratio of token money to commodity money wherever both are in circulation together) Accordingly Janaki Ram approaches Munna Lal in these terms ;—

"It is very inconvenient hauling up my boat every day. I would like to buy your beach but I have no money by me at the moment. However, I have lent Hira Lal five hundred shells till the cocoanuts are ripe which will be in three months from now.

Sell me your beach and I will transfer five hundred shells to your account in my bank."

Munna Lal, poor, innocent, suspecting nothing of the eggs; promptly agrees. And J. R. goes home and makes a note in the fishy old note book which he is pleased to describe as " my bank " that he owes Munna Lal five hundred shells. That's all. It doesn't trouble him in the least that Munna Lal begins the very next day to draw substantial cheques on his new account. As fast as the cheques come in he merely makes another

note that he owes Munna Lal so much less, and some one else so much more. He has successfully established CREDIT, the fourth, and most ghostly form of money. That uneasy and uncontrollable phantom will haunt these pages to the end so we need not say much more about it here. The problem of controlling credit is still baffling the statesmen of the world. In times of general confidence it expands to an incalculable degree. There seems to be no way of measuring exactly how many shells it is equivalent to. Let one or two serious failures take place, and it vanishes as if it had never been.

It is for this reason that, in times of general confidence prices are unreasonably high, and in times of depression unreasonably low. The high prices are the results of the ghostly inflation, and the low ones of it's disappearance.

Before we close this chapter we must offer a word or two of apology to Janaki Ram and the business men of whom he is the type. We have represented him as deliberately planning his various money making devices. In actual life he inherits them from his forefathers without clearly understanding their character. Only learned persons like the authors of this book are all knowing and of inflexible integrity. The rest of mankind is amusing itself with a variety of trumpery games. They have a kind of elementary morality which they describe in their childish prattle as;—

Playing The Game.

According to them a gentleman is one who observes the rules of his own game. The young ones hold that it would be ridiculous in a game of football to refrain from kicking a goal unless the goalkeeper had been given a week's notice in writing. The older ones say that the rules of their game don't require them to warn the holder of a beach they are trying to buy for an inadequate sum of money they haven't got, that it is charged with a valuable food stuff.

Many young students on first realising the nature of business affairs are horrified and rush to the conclusion that business is not a game a gentleman can play at. It is a too hasty conclusion. A gentleman is one who "plays the game" whatever it is. The reader may elect to play the game of business or not, as he chooses, or any other game. (Not ours, of course. He is probably not worthy todo that).

It will be his duty as a player of the game, to observe its rules, and if he can secure general agreement, to improve them. But he need not trouble himself about other peoples' games. He will never know enough about them to interfere usefully.

Appendices to Chapter (1)

(A) The student who after digesting his text book on a particular subject, wishes to extend his knowledge of that subject should not proceed to invest in a number of additional text books on the same subject. He will

find if he does, that each new book merely says in other words what the first did. At the best it will be found to contain one or two good chapters which were the real reason that it was written.

If any new books are bought, they should be monographs on particular branches of the subject. In the present case after (not before) having learned all that this book has to teach him he should proceed to books on;—

(a) Book keeping
(b) Banking
(c) International Trade

Or on any of the subjects indicated by the chapter headings. Or, if he desires rather to broaden than intensify his education he may read books in which "Economics of Engineering" is a chapter heading and thence go on to those in which "Economics" is a chapter heading.

There is, however, no hope that he will become an expert in any subject merely by reading books. It is obvious that no monopoly of knowledge is to be obtained in that way. He must observe the thing itself, which he may do, either directly, or through the medium of the periodical press. In this way he will gradually inherit the real fruit of education which matures long after he has ceased to be a student in the ordinary sense of the word. This inheritance is the opinion of the man who has been instructed to observe data for

himself and to form his own conclusions, instead of taking them ready made. It is always from a view point not accessible to any one else; the view point of his own character; always contains a new element of truth, and is always valuable.

(B) The Ordinary General Meeting of the Shareholders of the Midland Bank Limited was held at the Cannon Street Hotel, London, E. C. 4, on Tuesday, the 27th day of January, 1925.

The chairman (The Right Hon. R. Mc. Kenna), who presided, said:—During the year that has just elapsed Europe has made a remarkable approach to stable conditions of money. After almost unparalleled inflationary excesses a painful struggle is being made towards balanced budgets, national solvency, and a sound monetary basis. In England inflation was never carried to a point at which alarm could be felt for the permanent stability of our currency, but we have not been without our own anxieties. A reinstatement of the gold standard will be an event of first rate importance, and with your permission I should like to say something on the subject of currency values which covers all such topics as the relation between currency and credit, price level, trade and employment. Although the older economists throw but little light on the subject in its recent developments, some of the foremost of our modern teachers, both here and in America, are giving considerable attention to it. They point out that a

close connection exists between currency value and the volume of credit, and they discuss the possibility of a more effective use of credit control as a means of modifying fluctuations in the price level, preventing trade crises, and mitigating the extremes of unemployment. But we are still in the stage of enquiry rather than of positive opinion, and there is no formulated body of doctrine generally regarded as orthodox.

The problems of credit are in a sense inherent in the banking system, but their full gravity has only become apparent since the war. Before 1914 there existed a condition which concealed the underlying importance of credit control. The growth of joint stock banking occurred when gold was the basis of all the principal currencies, and the movement of gold regulated almost automatically the issue of currency and the supply of credit.

To-day we live under a new dispensation. In countries that have been forced off the gold standard we have seen the latent possibilities of credit inflation and currency depreciation, which had never in modern experience appeared in their extreme manifestations.

Changes in Purchasing Power.

During the ten years that the currency notes have been in existence our currency has varied widely in value or relation to its nominal gold equivalent, or in other words in relation to the dollar. The pound sterling is now finding its way back to parity and will probably soon stand at

its full gold value, not because it will have climbed uphill to meet the dollar but because the dollar under the pressure of the surplus supply of gold will have come down to the level of the pound. On the basis of the official index numbers, the price level in England has been more stable during the last three years than in the United States. Measured by the standard of purchasing power the pound, which is not on the gold standard and has no regular restriction on its issue, has maintained stability better than the dollar, which is based on gold. How can this happen ?

To answer this question we must turn our attention to a larger subject than currency. We have to consider money, of which currency forms only a part, and we must begin with a definition of the term.

Creation and Cancellation of Credit.

I understand by it all currency in circulation together with bank deposits drawable by cheque, which in the aggregate represent the purchasing power of the public. By far the larger part of our total money consists of bank deposits. The quantity of money is constantly varying, increasing or diminishing from time to time in consequence of the action of the banks. The price level is dependent upon the quantity of money, the rate at which it is expended, and the amount of goods and services available for purchase. The quantity of money is thus one of the three prime factors determining the price level, and it follows that whatever

controls the quantity of money is to that extent determining its value.

I am afraid the ordinary citizen will not like to be told that the Banks or the bank of England can create or destroy money. We are in the habit of thinking of money as wealth, as indeed it is in the hands of the individual who owns it, wealth in the most liquid form, and we do not like to hear that some private institution can create it at pleasure. It conjures up a picture of an autocratic and irresponsible body which by some black art of its own contriving can increase or diminish wealth, and presumably make a great deal of profit in the process. But I need hardly say, nothing of the sort happens. All that is done by the banks when they create money is to increase the amount of debts due to and from themselves.

Now, although a bank loan increases the aggregate of bank deposits, it does not increase the aggregate of bank cash, and it follows that, so long as each bank adheres to its conventional cash ratio, the power of the banks to create money is limited by their power to obtain additional cash.

Central Bank Control.

The action of the Bank of England in lending or calling in, buying or selling, regulates the cash held by the other banks, and inasmuch as this cash is the basis of their loans to the public it follows that

the Bank of England ultimately controls the amount of deposits, that is to say the amount of money.

The capacity to increase or diminish the quantity of money and thereby to depreciate or enhance its value, is inherent in the ordinary power of a central bank. If the currency is on the gold standard this power can only be exercised within narrow limits, as the movement of gold will very soon act as a check ; but where this standard is not in operation, the full responsibility for maintaining the value of money falls upon the central bank. The obvious guides to the central bank in directing its policy are the movements of the price level and the general state of trade and employment. Constant vigilance is needed on the part of the central bank to ensure that the causes of rising or falling prices are correctly diagonised. Nor does the need for vigilance end here. Many central banks do commercial business for their own customers They not only meet the needs of the money market in the temporary fluctuations of supply and demand, but they make domestic and foreign loans on their own account quite independently of the market conditions at the moment. Such loans may cause excessive ease of money ; their repayment excessive stringency ; and unless care is taken to counteract these effects when necessary, by a sale or purchase of securities, trade will be unduly stimulated or unduly depressed.

Gold as Regulator of Credit.

The larger movements in the sterling-dollar,

exchange have followed the course of the policy of the Federal Reserve Board. That policy has determined rates for money in the United States. When rates of interest were high, floating balances were held in New York and dollars bought in order to lend in that centre. When rates were low, dollars were sold and floating balances in sterling retained in order to lend in London. Thus money rates may exercise a powerful, though temporary, influence on the exchange through the transfer of balances. Ultimately the rate of exchange must approximate to the relation between the price levels in the two countries, but although this is the dominant factor there are other influences to which the exchange is sensitive and which operate upon it before the movements in price level can exercise their full effect. The recent rise of sterling in relation to the dollar has gone considerably ahead of changes in price level, but if the rise is maintained we may be sure the price levels will finally conform to the new relation of value between the currencies.

Superiority of Gold standard.

I have endeavoured to explain the meaning of a managed currency and the method of maintaining its value by regulating the quantity of money through the control of credit, and I have shown that during the last three years a managed currency has been kept more stable than one based on gold. We can supplement this favourable view by the further observation that considerable economy is effected by its use, as there is

no need to incur the cost involved in buying and holding gold as a reserve. But when so much has been said, and it must be granted that it is a great deal, the case for a managed currency must be regarded as closed. On the other hand the gold standard has in existing circumstances great and striking advantages. In the first place it establishes an international measure of value, common to the whole world and universally accepted. It is automatic in its operation and it relieves the central banks of a responsibility which, notwithstanding our own fortunate experience, might not always be discharged with the knowledge and judgment indispensable for the prosperity of national trade. It is not, however, wholly inelastic. There is still scope under it for an exercise of discretion by the central institution, as we have seen in the recent action of the Federal Reserve Board.

But in the present state of knowledge and feeling, one of the greatest advantages of the gold standard is its moral effect. A nation will think better of itself, will almost regard itself as more honest, if its currency is convertible into gold. The fear of being forced off the gold standard acts as a salutary check on the extravagance of Governments who might be willing to face a mere fluctuation in exchange but would not dare to suspend specie payment. It is a real advantage to a nation to have a currency founded upon a value which is universally recognised ; it inspires confidence and facilitates international transactions. Even if the gold standard

were not preferable for other reasons its universality would be decisive in its favour. The argument may, it is true, be founded on psychological and not on economic grounds, but it is none the less powerful, as we have not yet reached the stage where economic considerations alone guide us in judging the desirability of any particular method or system. So long as nine people out of ten in every country think the gold standard the best, it is the best. If in the future there were an immense increase or decrease in the output of gold and consequently a startling rise or fall in prices, reconsideration of the subject might be forced upon public attention, but at present there is no single nation, so far as I know, which is now off the gold standard that does not regard the return to it as the most desirable of all financial measures".

CHAPTER II.

Money in the Great World.

The commodity money throughout the great world is now gold. It is usually in the form of minted coins (specie) but occasionally for large payments in the form of bullion which consists of masses about the size and shape of bricks. Gold is so heavy that it would probably be quite safe to pile bullion by the side of a frequented road for half a day. The too ambitious thief would find that he could not carry it at the necessary speed for the necessary distance.

Attempts to establish gold and silver jointly (bi-metalism) persisted up to a few years ago, but they all failed owing to the impossibility of deciding once for all how many pounds of silver were worth a pound of gold. It is probable that no country is now on the gold basis, if we interpret that as meaning that it could give gold for all the paper it has in circulation. Up to the eve of the great war, however, several of the great nations were on the gold basis in as much as their national banks undertook to exchange gold for their own notes on demand. In practice it was found that all the chits were not presented at one time and even if an inconvenient number were, the resources of civilisation provided various expedients for discouraging the practice without absolutely forbidding it. This was the case in England and Germany, and excepting certain kinds of token

money, in France and the United States of America, also. The last is the only one now on the gold basis in the limited sense indicated above. It seems likely at the present moment (January 1925) that England will return to the pre-war practice sometime during this year.

A silver coin is a chit made of an alloy of silver. It is token money more durable and sanitary than if made of paper, and enjoys more respect on account of a certain intrinsic value which would remain if the promise it implies could not be fulfilled. This intrinsic value is, in the case of the Rupee, about twelve annas.

The forms of money with which the Indian student is familiar are therefore three only in number ; token money made of Silver, nickel, and copper; Cheques ; and Credit rooted principally in the power and prosperity of the British Empire. If only the token money existed, prices in India would be anything the Indian Government liked to make them.' They could be doubled or halved merely by doubling or halving the quantity of token money in circulation Credit, however, and the cheques like Munna Lal's on the morning after he sold his beach, representative of credit, are very difficult to control. In peaceful and prosperous times it expands. In times of war or political tumult it shrinks. The latter very frequently restricts the supply of goods also, which has a reverse tendency as we saw in Chapter I. It increases prices. Usually a sudden disturbance raises prices first, and then lowers

them, whereas one, long forseen and dreaded, merely lowers them. The final result is the same in both cases; general lowering of prices and business depression. A government might, and generally does with some success counteract these fluctuations by manipulating the supply of both token and credit money, but ;—

We are now in a region of conflicting interests and opinions, which have not yet reached equilibrium. The business community generally, finds a slow and continuous inflation the most pleasing state of affairs. Rising prices encourage buyers with the experience that if one waits a little a profit can always be secured. It is true that a time comes at last when it is discovered that a maund of money is required to buy a seer of rice, and when the exporters from other countries refuse to admit that the money has any value at all, but until then it is cheerful. On the whole, however the inflationists are dwellers in the Pit of Illusion.

There are also deflationists. They are all those whose income is fixed, or who are already possessed of considerable sums of money, and not of other forms of wealth. For them, lowered prices mean that their own possessions increase relatively to those of the rest of the community. They can buy more of anything with the same money.

Instructed, and unselfish opinion favours neither inflation nor deflation ; but when everyone is instructed and in favour of stability, there will still remain the problem of credit.

The Monetary System of England.

Its unit is the "pound", the symbol for which is £, just as Rs. is the symbol for the rupee. Rs. 500-0-0 means five hundred rupees, and £ 500-0-0 means five hundred pounds. The pound is divided into twenty parts called "shillings" and the shilling again into twelve pennys or pence. Token coins are in circulation for the two last, the first a silver alloy coin and the latter a large and clumsy copper one about as big as a rupee. Just as Rs. 30-8-9 means thirty rupees plus eight annas plus nine pies, so, £ 30-8-9 means thirty pounds plus eight shillings plus nine pennys.

In normal times when England is on the gold basis, its mint will buy one hundred and thirteen grains of gold for a pound or the Bank of England will sell pure gold for its own notes at the same rate. Under these circumstances the value of a pound is definitely fixed (in terms of gold).

It is not definitely fixed in terms of any other commodity, but gold is a very good representative one to nail a currency system to. Some sufficient food stuff might be better in a poor country like India, but there are difficulties in that. The Bank of India would have to replace its vaules by large granneries. and there would be danger of loss through deterioration of the rice (gold). Gold does not decay no matter how long it is kept, but under certain circumstances as in the United States

of America at the present moment, a great increase of it may increase prices, just as any other kind of inflation does.

If India followed the practice of England, the value of the rupee could be arrived at by simply comparing the ammounts of gold that a rupee would buy at the Imperial Bank of India with the amount that a pound will buy at the Bank of England. But as we have seen, India is not on the gold basis. At present about thirteen rupees are being paid for one pound, by those wishing to change rupees into pounds.

The Monetary system of the United States of America.

The unit is the dollar (Symbol, $). The value of the dollar may be exactly computed in pounds because both countries are normally on the same basis ; namely, gold. It would not be so simple if one of them were on, say, rice basis. A pound is worth $4. 86 (In words, four dollars and eighty six cents). It will be observed that subdivision is on the decimal system. It is left to the student to calculate the present value of a dollar in rupees from the data already given.

As a result of the Great War we can give only the names of the units of the other great Western countries. Both France, and Germany have now a purely token currency, over-shadowed by wildly fluctuating credit. The opinion of French merchants is, that their "Franc"

is at the moment worth about one nintieth of a pound. That is what they are giving in Paris and other large French towns. Before the war the value of a franc was one twentyfifth of a pound. The French system like the American is a decimal one.

With the exception of certain small neutral Nations, other European countries are still in the post-war chaos as regards their currencies, and it would serve no useful purpose to examine them here—as they were. But the student is advised that he may watch their struggles towards renewed stability. If he does so carefully he will learn more about the nature of money than he is likely to learn from any book. He has an unique opportunity to observe the thing in its making.

Appendix to Chapter 2.

From the "Pioneer" of May first 1925. Part of the Budget Speech of the Chancellor of the British Exchequer delivered on April 28, 1925.

"Announcing the return to the gold standard, Mr. Churchhill said that such a return was a long settled policy of the country, only the question had been a most difficult and delicate one of how and when.....It was unnecessary to adopt gold coinage. He appealed to all classes to continue to use notes. He would introduce a bill providing that, until otherwise provided by proclamation, Bank of England and Treasury notes be convertible into gold only at the option of the Bank

of England, and that the right of tendering bullion at the mint to be coined be confined in future legally to the Bank of England, which would be obliged to sell gold bullion in amounts of not less than 400 ounces in exchange for legal tender at the fixed price of £3-17-10½ per ounce. Further steps would be deferred until we had sufficient experience of the working of a free international gold market on a gold reserve of approximately £ 150 millions"

CHAPTER III

Capital

It will be sufficient for our purpose to define capital as accumulated money in any or all the forms described above. From the engineer's point of view the use of capital is to support the workmen, and buy the raw material for enterprise not immediately productive.

The owners of capital customarily hire it out on terms depending on the risk they run of losing it. or part of it. If the enterprise for which the capital is required is one certain to prove remunerative, and if the persons requiring the capital are entirely trustworthy, the charge is between four and five per cent at the present time. That is to say between four and five rupees per annum rent (interest) will be charged for every hundred rupees borrowed.

We have said that if the enterprise is certain to prosper, and if the borrowers are entirely trustworthy the charge is four or five per cent per annum ; but this is a very rare combination. The most trustworthy borrower is a great and prosperous nation. If the enterprise for which it requires capital is, say, a system of irrigation or the education of its rising generation, both conditions are satisfied, and the interest will be the lowest possible. On the other hand, if the enterprise is war, a higher interest must be paid, because

there would be no wars if the result was always certain

In the present state of the world there are a number of powerful nations willing to borrow all available capital at about four and a half per cent. Even if they are not borrowing money at the moment their old creditors are so numerous that one can always be found ready to transfer his claim to anyone that wishes to invest in it, and has the money to pay for it. Perfectly safe "guilt edged" investments of this character are always available throughout the world.

It should now be evident that no capitalist will invest money in, say, an engineering business floated by a company, if only four or five per cent is offered. He will require a much higher rate of interest to compensate him for the risk and anxiety which has practically no existance for the investor in guilt edged "securities". Nor would it be practical in the business sense for the company to embark in an enterprise which did not offer a still higher rate to cover depreciation on perishable plant and the like. For these and similar reasons it is not of much use trying to interest the capitalist in a scheme which offers anything less than ten percent on the capital required. There should be a clear prospect of ten per cent after allowing for depreciation due to wear and tear and other wastage of the property.

The above does not apply, of course, to national or municipal entreprises. These are often justified on quite other grounds than the possible profits. The

sanitation of a city, or the foundation of a university are examples. Such undertakings are in the long run the most profitable of all, but the profits are not usually reaped by the people who initiate them. They are repayments to the unborn of a debt owed to our forefathers, and exist, where they do, because there are motives for human action more powerful and enduring than any of those that the science of economics takes account of.

How capital is raised

"Raised" means borrowed from the community at large. Formerly, and still, to a certain extent this was done by negotiation among friends who formed a "partnership" to carry on the work. Those who contributed capital were "partners" in the business. The partners who took part in directing it were "active" partners, while those who merely contributed were "sleeping partners". The great advantage of a partnership is that its operations may be secrect. It may make very large profits without attracting competition, and enjoys generally the freedom of a private individual within the law.

But there is a great danger in partnerships which prevents them from raising money easily. The liability of the partners is unlimited. Even a partner so sleepy that he lends money on the understanding that he is to have a share of the profits without inquiring what the partners are going to do, is liable. Any act of the managing partner or partners in the name of the partnership is

regarded by the law as the act of all the partners. On the other hand if the sleepy one lends money at a fixed rate of interest, he is a creditor, not a partner, and in the event of disaster may claim his pound of flesh even if the others are entirely ruined by his claim. The managing partners may incur debts without the knowledge of the sleeping ones exceeding a hundred times the account contributed by the latter: who are nevertheless compelled to repay them, whether the business when it breaks up has anything to show for the money spent or not.

We have stated the law in regard to partnerships very simply in order to emphasize its essential features. In fact it is not only complex, but also rather vague. The points which the reader should fix firmly in his mind are :—

(a) Partnerships are DANGEROUS.

(b) Anyone who is his own lawyer in partnership affairs has a fool for his client.

Limited Liability.

This invention was perhaps as great a factor of industrial advance in the latter half of the nineteenth century as the steam engine was in the first half. In commercial progress it ranks with the invention of token money, and double entry book keeping. Its principle may be very briefly stated.

The liability of the partners is limited, either by the number of shares the partners have taken or by a

certain sum they have guaranteed; nearly always by the number of shares.

Thus, if a person applies for one hundred ten rupee shares in a new company or buys the same number of the same nominal value in an old one, he cannot be called upon for more than a thousand rupees first and last. He may, in the first case, have paid only five rupees for his ten rupee shares, (the shares were "partly paid shares") in which case he may be called upon for the balance. He may in the latter case have bought the ten rupee shares in an old and successful company for much more than ten rupees each. But that was consciously, and by negotiations which did not concern the company. Share money consolidated into large blocks and sold by quantity instead of by number is called "**Stock.**"

The reader should now understand how much more easy (not simple) it is to raise money for a limited liability enterprise than it is for a partnership. The shareholder knows exactly what risk he is running. He may (in fact he probably will) lose the money he subscribes but he cannot lose more. We are justified in saying he probably will by the fact that more than half the new companies that are floated every year fail to continue floating. They sink after a year or two leaving no trace except, occasionally, a disagreeable smell. It may be said therefore that subscribing for shares in a new company is a species of gambling. It is:

but it is very amusing, the proportion of prizes is quite high and now and then the prizes are tremendous.

If the company is so successful as to make say fifty per cent on its capital, that fifty per cent is a mere trifle compared to the lucky shareholders' real profits. He may now sell his ten rupee shares for rupees fifty or more each, thus bagging not fifty per cent, but four hundred per cent, and at once setting free his capital for fresh adventures.

It was the prospect of such prizes that charmed the savings out of the pockets of Western peoples from 1860 to the present day, and financed the great material advances of that epoch. It also leads foolish and credulous people to buy shares in enterprises which have no attraction but the optimism of their promotors, and no reason for their existance other than the anxiety of these gentlemen to unload a worthless property on the public.

The law does what it can to protect these innocents. It insits that the invitation to subscribe (called the "prospectus") shall contain no deliberate lies or suppressions of the truth. It cannot of course guarantee that the cheerful optimism that always characterises these documents is honest. The reader in his happy visions of a possible four hundred per cent has forgotton the possible creditors of the limited liability company, but the law remembers them. Their security is not nearly as good as it was in the case of the partnership.

The law protects them by requiring the company to disclose the fact that its liability is limited, in all its dealings. Finally we may say of company law what we said of partnership law that no one should meddle actively with it without expert assistance. But if he has a taste for gambling, or if he has reason to think the enterprise worthy of support, he may buy shares. Most of us try a flutter in that direction now and then, and can exhibit singed feathers as a result.

At the worst one loses the money paid for the shares; or if the shares are partly paid the unpaid portion in addition.

Classification of Shares.

The promoter of a company, endeavouring to raise money from the public, usually appeals to two classes of investor in the first instance: to the man who would very much like to make more than the four or five per cent he could get from guilt edged investments, but who hates the idea of losing his money, and to the reckless person who thinks the chance of four hundred per cent well worth the risk. To the first he offers PREFERENCE SHARES. The preference is of various kinds. Usually the preference shareholder is guaranteed that he will receive his limited dividend before the ordinary shareholder gets anything, say six or seven percent, but no more, no matter how large the profits may be. Sometimes the shares are CUMULATIVE PREFERENCE SHARES. If the company fails to make a profit in any year, the preference shareholders must be paid their arrears before

the ordinary shareholders get anything in subsequent and more prosperous years. Occasionally there is PREFERENCE AS TO CAPITAL also. In that case, if the company fails, and its assets are sold, the preference shareholders have the capital they subscribed returned first, and the ordinary shareholders get what is left.

The third kind of share is the DEBENTURE issued by a successful company which requires more capital for development. It is merely an acknowledgement of money borrowed at a fixed interest and for a fixed period, on the security of the company's property. The interest is usually, but not always less than that offered to preference shareholders, but of course, more than could be obtained from guilt edged stock. Theoretically a debenture shareholder gets his interest whether the company makes any profit or not, but in practice he does not always find it wise to insist on his rights in that respect. There may be a risk of killing the goose, which if not laying golden eggs at the moment may if it lives, still do so at some future date,

Once these shares have been issued, and paid for or partly paid for, they continue to be bought and sold by the community at large like any other form of merchandise. The price at which they change hands varies in accordance with fluctuations of trade, and is sometimes lower, and sometimes higher, sometimes the same as the original or nominal price. If the market price of a hundred rupee share is one hundred and five rupees it is said to be at a PREMIUM of five percent; if

ninety-five, at a DISCOUNT of five per cent, and if it is still one hundred rupees the shares are AT PAR.

The bazar in which shares are bought and sold is called ;—**The Stock Exchange.**

There is a stock exchange in most great cities. It is a private corporation controlled by its members whose profession it is to deal exclusively in stocks and shares. There are other persons who deal in stocks and shares, but the reader should note that outside dealers are not usually gentlemen in the sense explained in Chapter I, whereas a member of the stock exchange usually is. The members divide themselves into two classes in a properly organized exchange ; JOBBERS who buy and sell on their own account, and BROKERS who act as agents between the public, and the jobber. Ostensibly a jobber is equally ready to buy or to sell any share on the market. When approached by a broker inquiring his price for a particular share he quotes two prices ; a high one at which he will sell and a somewhat lower one at which he will buy. Only when he has done so should the broker disclose whether he has a commission to buy or to sell. If the broker is a gentleman he is concerned only to do the best he can for his client. It is not "playing the game" for a broker to speculate in shares himself, as it might give him interests opposed to those of his clients.

Bulls and Bears.

The jobber who quotes prices at which he is quite as likely to become a seller as a buyer is depending on

the "turn of the market" or difference between his selling and buying price for his profit. He is neither a bull nor a bear. But one who consistently quotes high prices, will of course always be asked to buy, and never asked to sell. He is a bull (for the time being). He either believes that prices are presently going to rise on their own account, when he will sell his accumulation of stock at a profit or he is combining with other bulls to create the illusion of a real demand which as every one knows raises prices, quite apart from any real fluctuation in their value. The bull hopes to have sold at a profit before the illusion is discovered. The final buyer who is left to discover the illusion is in general not a jobber but a member of the general public. It is illegal in most countries to "CORNER" any particular share, that is to buy more of them than there are on the market. The idea of cornering is that when the unfortunate sellers have to make delivery they find that they cannot do so, and have to appeal to the nice kind bull to sell them a few shares to make up their deficiency. He of course having plenty of shares will be quite ready to do so—at a price.

The whole proceeding is of course a rank steal and illegal but though it is a crime it is not so easy to bring home to the criminals as it would appear to be at first sight. When the thing is discovered it is also discovered that all available shares are in the possession of a number of innocent optimists who think their shares really worth what they ask for them. According

to them nothing could be further from their minds than cornering. Another set of gentlemen, totally unconnected with the first, of course, insist that the real criminals are the wicked bears who sold shares they had not got. Why should they not claim delivery of the shares they bought in perfectly good faith ? Also why should the optimists be compelled to sell the shares they have bought in perfectly good faith for less than they honestly consider them to be worth ?

As a matter of fact the bears are just as much to be blamed as the bulls. They have been selling shares hoping to create the illusion of a tremendous supply and so create an artificial fall of prices. If they can succeed in raking together more shares than the bulls can buy ; then when settling day comes the bulls will have to sell to realise the money they have contracted to pay for shares they never expected to be delivered. Then it is discovered that the pessimism of the bears has become really dreadful. They don't want the shares at any price now. However, just to oblige their old friends, they are willing to take a few at about a tenth of the price the poor old bulls paid for them. It is a bear victory !

Neither the bulls nor the bears deserve any sympathy from the general public. They are in fact a nuisance and are engaged in one of the most childish and mischievous games that adult men engage in. We must confess that we are childish enough ourselves to be much amused at their little games and for that reason have

perhaps given them more space than they deserve. Our reason for mentioning them at all was to warn the reader that wild fluctuations of the price of anything which last only for a few weeks have very frequently no rational basis. He should not rush to buy a rising stock just because it is rising. If he does his fate is likely to be to assist a bull operation without sharing in the profits. Nor should he rush to sell any valuable shares that he may happen to have simply because the price has suddenly started to fall. The bears will welcome his assistance, but they will not give him a commission on their modest gains, if they are successful. It is almost a general principle, that to buy when every one else is buying, is as foolish as to sell when every one else is selling. The reverse is a better rule. But better than either is to form one's own judgment of values independently of the mob, and to act accordingly.

The reader, who in spite of our manifold warnings is still determined to have a try for that four hundred per cent, will have in the first instance to get into touch with a stock broker (unless his particular folly is a new company), who ought to be a member of the stock exchange. Remember that respectable stock brokers do not advertise, it is against the rules of their game. He may give an open order to buy a particular stock. He will always have to pay the higher of the prices quoted in any good financial paper a day or two after the transaction takes place. On the other hand if he gives a selling order he will get the lower price. Jobbers must live.

He may, if he likes, give a conditional order to buy at a price not greater than the one he is willing to pay. The broker will require a commission of rather less than one per cent of the money involved in the transaction as a rule. It is less for a straight forward guilt edge investment than it is for the more speculative shares.

Private Companies :—

Are none of our business of course, but we will be expected to know what they are. They are limited liability companies whose shares are not sold to the public. Sometimes they are merely dodges of wealthy men to avoid the payment of income tax.

Appendices to Chapter III.

(A) Quoted from "Elementary Principles of Economics" by Professor Irving Fisher.

"A stock of wealth existing at a given instant of time is called Capital (Wealth consists of material objects owned by human beings and external to the owner). A flow of benefits from wealth through a period of time is called INCOME.

Many authors restrict the name capital to a particular kind or species of wealth or to wealth used for a particular purpose such as the production of new wealth; in short to some specific part of wealth, instead of to any or all of it Such a limitation, is, however, not only difficult to make but cripples the usefulness of the concept in economic analysis.

(B) The following are the titles of interesting novels dealing with stock exchange operations.

"The Pit" by Frank Norris.

"Letters of a Self Made Merchant to his Son" by E. Lorrimer.

CHAPTER IV.

International Money.

In this chapter we are concerned with the mechanism by which money is transmitted from one country to another which has a different system of currency such as any of those described in Chapter II. Incidentally we shall, if we watch carefully become aware of a method of substituting credit for currency second in importance, only to the method of c eating bank credits.

Let us suppose that a certain gentleman named B. C. Chatterjee of Calcutta, has collected and shipped to London a quantity of rice which he has sold to a gentleman there, named L D. Coueslant, for £3000-0-0 on the understanding that it will be paid for in three months. Now, Mr. Coueslant has got money only in pounds sterling, whereas Mr. Chatterjee would naturally prefer to be paid in rupees. He has to pay the farmers who grew the rice, and these have no use for pounds. Accordingly he "DRAWS a BILL" on Coueslant. The bill is in this form :—

"Three months from date pay to my order the sum of £3000-0-0."

To L. D. Coueslant Esq.
London.

(Signed)
B. C. Chatterjee,

If Coueslant has agreed to these terms, he will on receipt of the bill write across the face of it ;

"Accepted, L. D. Coueslant."

and send it back to Chatterjee in Calcutta, who may realise ready money in rupees on it (after endorsing it) by selling it either to a bank, or to some merchant in Calcutta who has occasion to make a payment in London, no doubt for something he is importing from there. The buyer and Chatterjee will have to decide between them what a bill payable in sterling a month and a half in the future is now worth in rupees. The amount they deduct because it is not immediately payable is the "'DISCOUNT'. The number of rupees they decide (no doubt after a long argument) to accept as the equivalent of one pound is the "RATE OF EXCHANGE" usually quoted as so many pence to the rupee.

The buyer may in turn endorse it, and resell it and it may at last reach Coueslant with a dozen endorsements by so many successive owners. If Coueslant fails to pay up when that happens, the last owner can claim from the person who endorsed it and sold it to him, and so right back to Chatterjee who originally drew the bill. Every endorsement is an additional security. A glance at the title page of this book will show that the name of the drawer of this particular bill and of its drawee are of extraordinarily good repute. In such cases the drawer (Chatterjee) may discount his bill immediately he draws it in anticipation of acceptance.

The important thing for an Indian to notice is that the rate of exchange between England and India is settled by negotiation between Indian merchants The English

merchant has nothing to do with it, nor has the Indian Government, except in as much as it may appear in the bill market as a seller or buyer of bills on its own account. The Government by thus intensifying demand or supply may greatly influence the price (rate of exchange) of bills, but it does not determine it.

We are supposing that the buyer of the bill sends it directly to his London creditor who collects from Coueslant in due course. This may happen, but Chatterjee is just as likely to find a customer in a merchant who has to make a payment in Pekin. His bill is a very sound one, and such bills on London circulate all over the world as a kind of international money. If this particular bill should come on the market again in Pekin, Chinese merchants will have to decide how much a pound is worth in their currency. It is always the merchants of the other country that have to decide the rate of exchange between that other country and England. London has nothing to do with it.

As the rate of exchange between India and London troubles Indian thought a good deal it may be worth while to consider the factors on which it depends. Bills are like any other commodity in that the price depends on demand, supply, and the total quantity of money circulating in the country in which their price is determined.

Demand;—is from merchants desiring to make payments in London, that is to say from Indian importers. If there are more than usual of them, (imports are rela-

tively high) the merchants in question will get fewer pence for a rupee. The exchange "moves against India."

Supply;—Of what ? Of Bills ? Not exactly that. It would be better to describe it for the moment as a supply of pounds. Looking at in that way we will see that supply may be increased in two ways; by INFLATION of the English currency and by many men like Mr. Chatterjee (exporters) drawing bills on London. Either or both of these working together tend to cause more pennys to be given for a rupee (to make the exchange move in favour of India)

Finally there is the quantity of money, circulating in India. An increase in that raises prices all round including the price of a pound stirling (causes the exchange to move against India).

This last factor shows the government to have the same power over exchange that it has over bazar prices (provided it can control that part of money which is credit). Moreover, bazar prices are lowered by the same operation that improves exchange; namely, DEFLATION. The question is ;—does India want lower prices in the bazar ? On that point the reader had better read Chapter II once more.

Exchange between gold Standard countries:—

Cannot vary much. If a merchant in New York finds hat he is asked to give much more than $4: 86 for £1-0-0 he buys gold at his own national bank and sends that to his creditor.

He makes up for a national deficiency in exports by exporting gold. The maximum adverse exchange he has to fear is the freight and insurance charges on the gold. It means very roughly that the pound under these circumstances costs him about five dollars.

Banker's-Drafts :—

Are bills drawn by Indian banks on their London correspondents or branches to the order of their Indian clients and sold to the latter without or rather in anticipation of acceptance. The rate charged by the bank is rather higher than the rate at which bills may be had in the bill market, but for the person who has only occasionally to make a payment abroad the banker's draft is the best and safest method of doing it.

Money Orders

Any post office in India will sell small bills called foreign money orders to any one that applies for them, drawn of course on the English Post Office. Their rate is still higher than that charged by the bank, but for quite small amounts the saving of bankers commisson and general fuss and worry at both ends makes the Money Order the best and most convnient method of sending money abroad.

The tax on all bills, is proportional to the amount for which they are drawn. In this they differ from the cheque which bears a one anna stamp for all values.

Smith on Smith

We have already remarked that Chatterjee's bill on

Coueslant of London derived great strength from the names of these gentlemen. It is extremely painful to our modesty to have to insist so much upon that, but it is necessary. There is another way in which the bill might have been less excellent than it was. There might have been no rice. The existance of the rice, presumably worth more than £3000 0-0 in London, safely shipped, insured, and on its way consigned to Coueslant made it practically certain that he would be in a position to pay when the time came to do so. A BAD BILL is one drawn by some hard-up gentleman in one city on some "bhai" in another who is just as hard up as he is. The Smith in Calcutta who draws a bill on Smith in London (or an inland bill on Smith of Bombay) does so in order to discount it and raise money for some immediate necessity. He hopes, that when the fatal day of the bill's maturity arrives, the luck may have turned in his favour, and he may be able to meet it.

Good bills like the first one described are "TRADE BILLS." Bad ones like the second are "KITES" or collectively, "Smith on Smith". Both are legal; but the first is legitimate, while the second is not legitimate business. It is not playing the game to draw or accept a bill without a reasonable prospect that it will be honoured.

The Appendix consists of two cuttings from the Pioneer of March 27th. 1925. During the war and for nearly ten years after it Germany supplied her financial necessities by an enormous inflation of her paper currency. The exchange accordingly "Moved against

Germany " till her mark originally worth one-twentieth of a pound, became worth only one-twenty billionth of a pound. At that stage a fresh start was made with a currency founded on a large loan of gold from her late enemies, the old mark being abandoned as lost.

IT WILL BE NOTICED THAT ON THE FINANCE page of to-day's issue of The PIONEER the quotation for the German mark is given as 20.08¼. This, of course, is the rate for the new gold mark, which has long since replaced the paper mark as the medium of currency for the transaction of business in Germany. To all intents and purposes the old paper mark has been defunct for some months, the currency having been stabilised last November at one billion paper marks to the new gold mark.

LATEST FOREIGN EXCHANGE

BY SPECIAL CABLE FROM LONDON.

CALCUTTA, 23TH MARCH.

The following were the exchange rates on London at the following places on the 24th March:—

Paris ...	...	...	91.50
Italy ...	...	...	117.64
Berlin (Gold marks)	...	...	20.08¼

CHAPTER V.

Trading Abroad, and Transport.

The word INDENT has a meaning in India, and the East generally, peculiar to these countries. Normally it means a contract between two persons, but here it means an order to supply goods under certain conditions embodied in the order or rather, that was its original meaning. At first when trade with the East was in its infancy, an indent form was supplied to the importer in India by his supplier in the West. It contained an elaborate set of conditions binding the buyer to take delivery of the goods ; to pay for them within a stated period ; allowing the exporter to sell them to a third person if the first failed to take delivery, without forfeiting his claim on the original buyer. Etc. Etc. To all these conditions the buyer agreed when he signed the indent supplied to him by the seller. But this state of affairs no longer exists to any extent. Only the custom of calling an order an "INDENT" remains of it.

The conditions of sale are now usually embodied in a document called the QUOTATION which is the seller's reply to the buyer's inquiry. It usually begins with a very exact and careful description of the goods, called the SPECIFICATION. Then comes the price together with the time at which payment is expected ; wholly or partly in advance, on delivery of railway receipt or bill of lading, or some fixed date later. Finally in a very

contracted form is stated how much of the cost of transport and other expenses in addition to the price is to be paid by the seller.

" F. O. B. London " (Free on Board the ship at London) means that the seller will pay the charges of transport up to the moment when the goods are loaded on the ship at London, but no more.

" Ex Ship " (out of the ship) means that the seller will not pay for any charge for unloading from the ship at the port of delivery.

" Ex Warehouse Calcutta" means that the price is that at which the goods will be delivered in Calcutta. The buyer will have no freight charges at all to pay for the transit over sea, but he will have to pay for getting the stuff from the warehouse to the railway station in Calcutta, and all subsequent charges.

C. I. F. (Cost, Insurance, and Freight)

F. O. R. (Free on Rail)

It will be seen that the conditions embodied in these abbreviations are of great importance. There is a great difference or ought to be a great difference between the quotation for a Lancashire boiler (say) quoted F. O. B. London and the quotation for the same size of boiler., C. I. F., F. O. R. Calcutta. The former, though it may look much cheaper at first sight, may actually be the dearer of the two.

There is an ambiguity about the 'C' in " C. I. F. " It may mean that the seller will pay custom (Import duty) in certain cases. On the other hand if the quota-

tion is "In Bond" there is no doubt about it. The goods are sold INSIDE the custom house, and the Custom house officers will see to it that the duty is paid before they are removed.

Whatever the conditions quoted may be it is the seller who now-a-days proposes rather than dictates them by his quotation. The indent or order is a formal agreement which does not generally repeat all the details. It takes the form of a request to supply in accordance with the quotation.

Bill of Lading.

If the goods are supplied F. O. B. London, the owners of the ship in which they are loaded will acknowledge the receipt of them in a terrifying document (made out in triplicate) called a BILL OF LADING. It contains a description of the goods, and in the margin a copy of the marks on the packages; the name of the ship, and of her master (Captain); the port of destination; the route; the name of the person or firm that will be entitled to receive the goods on arrival (the consignee); the "LIEN" of the shipowners on the goods, (their power to hold them as security for their charges); and for what kind of damage or loss the shipowners will be responsible or not.

The law would enforce these conditions, of course, just as it would enforce the conditions on the back of a railway ticket, but most of them provide for contingencies that do not generally arise.

Of the three copies that are made of the bill of lading; one remains with the ship-owners, one with the

master, and the third is sent to the consignee (the person or firm to whom the goods are being sent.) This bill of lading which the consignee receives is a "NEGOTIABLE INSTRUMENT" like a bill of exchange or a cheque.

The basis of a cheque is money in the bank. The basis of a bill is the credit of the drawer and drawee. The basis of a bill of lading is the goods in transit to which it is the title.

Just as the payee of a cheque may endorse it and hand it over with all the rights which it implies to anyone else, so the consignee of a bill of lading may endorse it and hand it over to some one else to collect the goods. If he lives somewhere distant from the port he will probably find it most convenient to hand it over to one of the shipping agents that carry on business in such places. The agent will receive the goods in return for the duly endorsed bill of lading, pay all charges, and send the goods on to him. No trouble at all. But the agent will expect to be paid for his services.

The arrival of a "tramp" (wandering cargo steamer) at its destination is notified to the consignees of the goods on board her by advertisement in the local newspapers whereupon they are expected to make arrangements to receive their goods ex warehouse or ex ship as the case may be.

Railway receipts.

Except that they are cheap and shabby affairs printed on flimsy paper they are for all practical purposes bills of lading for goods sent by rail.

Cost of Transport

Like all other things on the market, it varies with supply and demand, and unlike most of them is very much influenced by local conditions, as, for instance, whether there is or is not a direct road or railway connecting the termini.

We shall have to take a fairly wide view in order to discover such general principles as there are.

The student should think of it as made up of two separate charges: The cost of loading and unloading, and the actual carriage cost. Loading costs are proportional to the number of loadings and unloadings, commonly four in number:—

(1) Lorry (2) Railway (3) Lorry (4)

The words indicate carrying, and the figures loading or unloading.

If both seller and buyer have railway sidings this reduces to ;—

(1) Railway (2)

If both have their places far from the sea, in different countries, and not on railway sidings it becomes ;—

(1) Lorry (2) Rail (3) Ship (4) Rail (5) Lorry (6)

a sea port where the docks have not got a railway siding being rare. As a rule goods can be loaded directly from the ship into the railway waggons and vice versa.

A loading or unloading will cost say, annas eight per ton. It may be much less for goods of a special

character, such as coal or grain for the lifting of which special lifting devices usually exist at loading points, and it may be much more for heavy and bulky machines where no facilities exist.

The charge for carriage by sea depends on the nature of the goods, and a ton may be interpreted as meaning so many cubic feet of space. It is about one twentieth of an anna per ton per mile. Carriage by rail is about ten times as costly, while the motor lorry will usually work out at about two annas per ton per mile. All these figures are very rough, and are given only as data for the following examples.

About fifty tons of goods have to be sent overland between two points ten miles apart, neither point being on a railway though both are close to railway stations. Should they be sent by road or rail ?

If they are sent by road there will be only two loading charges, costing fifty rupees. The cost of carriage will be Rs. 62-8-0 for five hundred ton miles at annas two per ton mile: total Rs. 112-8-0.

On the other hand if they are sent by rail the loading charges will be Rs. 100-0-0 and the carriage cost Rs 115-10-0 total Rs 215-10-0.

On the whole this example indicates the motor lorry as being the cheapest form of transport. It is very unlikely that the railway runs directly between the points. The distance by rail may well be fifty instead of ten miles. Moreover there is likely to be much delay.

If the reader works out the above example; substituting one hundred for ten miles, he will find that in that case the railway has much the better of the comparison, even if the distance by rail is two hundred instead of one hundred miles by road. With other somewhat different assumptions, as to cost per ton mile, and cost of loading and unloading, we might have found the lorry cheaper up to fifty miles, but the result of all such calculations, is to demonstrate that only for short distances, can the motor lorry compete with the railway. It usually has an advantage in speed of delivery up to rather greater distances.

The relations between costs of transport by sea and by rail are similar. Where both termini lie on a comparatively straight coast line, and the number of loadings is the same, the sea is much cheaper for all distances.

We will leave this subject in a vertical direction. Reader; "What on Earth do you mean by that"? Authors; "We mean of course, that we will conclude with a bird's eye view"

The great advantages of the sea are that there is no capital cost for the road and that the road goes to so many places. The advantage of the rail over the road is the low tractive effort per ton, and its great handicap as compared with both the road and the sea is the heavy interest charges on its capital cost. This last

charge; namely interest on capital cost per ton mile diminishes as the density of traffic increases. Wherever the traffic is dense the railway can compete with the road down to a distance of about ten miles, that is to say, between great centres of population but not within them. Wherever new inland country has to be opened up for commerce, the motor is the best for any distance, until such time as traffic becomes dense enough to bear a railway.

APPENDIX TO CHAPTER V.

Selected cutting from the commercial pages of the Calcutta "Statesman".

FREIGHT MARKET.

CALCUTTA, SATURDAY.

A fair business in jute bookings for the Continent March shipment has been done during the week and the Hansa Line are again out of the market for March. Rather more interest has been shown in forward seed positions.

Bookings reported amount to about 6/7,000 tons linseed, jute for U. K. Continent March-April.

CALCUTTA TO LONDON, LIVERPOOL DUNDEE MIDDLESBORO, GLASGOW.

(less 10% rebate not exceeding 5s. per ton).

		s.	d.
Jute	per 50 c. ft. ...	40	0
Cotton	do. ...	40	0

Gunnies	per 50 c. ft.	...	43	9
Hides	do.	...	43	0
Tea (less 5s.)	do.	...	47	6
Shellac	do.	...	45	0
Linseed	per 20 cwt.	...	40	0
Wheat	do.	...	37	6

BELFAST, BRISTOL, CHANNEL, LEITH AND HULL.

300 tons 5s. over London rate. 501 tons to 1,000 tons 2s. 6d. over, more than 1,000 tons 1s. 3d. over.

ROTTERDAM, HAMBURG, BREMEN.

Antwerp.

(Nett Rates.)

			s.	d.
Jute	per 50 c. ft.	...	35	0
Gunnies	do.	...	37	6
Hides	do.	...	37	6
Linseed	per 20 cwt.	...	35	0
Shellac	per 50 c. ft.	...	38	9
Deadweight	per 20 cwt.	...	32	6

CHAPTER VI.

Banks and Insurance Companies.

The management of these institutions and its highly developed technique does not come within the scope of this book, but it has been thought advisable to include a short chapter describing them from the outside so that the young engineer may know what services he may expect from them. From this point of view the business of a bank is to receive and safely guard money not needed at the moment. No charge is made for this service as the bank relys for its profits on the investment it makes of the money so deposited. Most of the money in the bank never goes out in a community sufficiently civilized to make a proper use of the bank. As we saw in Chapter I, the bank, on receipt of a crossed cheque, has simply to make a note that it owes one of its depositors so much less, and another so much more. It is not necessary to disturb investments. It very often happens that the accounts of payer and payee of a cheque are in different banks, but even in these cases the banks arrange mutually by means of institutions called clearing houses to let one cheque cancel another without any disturbance of investments.

It is of course very profitable to have the investment of large sums of money received without equivalent in

this way, and therefore the banks offer inducements to the general public to deposit its funds and to leave them in the bank's custody for as long as possible.

Money deposited on the understanding that it may be withdrawn or transferred to another client of the bank at any moment without notice is on "CURRENT ACCOUNT".

As a rule a bank makes no charge for keeping a current account unless it is a very small one, nor does it allow any interest on the money "on current account".

If an undertaking is given to leave the money deposited undisturbed for three months; six months, or a year the bank will allow interest on it, at a rate which is higher the longer the period undertaken. Such amounts are said to be on "DEPOSIT ACCOUNT"

The other side of a bank's business is of course the investment of the money entrusted to it. It is, on this side of its business that the bank requires to be watched. Every bank exhibits the state of its affairs more or less openly by means of a document called its "Balance sheet" which is issued at least once a year and usually once a month.

The balance sheet shows on the left under the heading "LIABILITIES" how much it owes, and on the right under the heading "Assets" how much property and of what kind it has to meet these liabilities. A typical balance sheet contains items like the following;—

Liabilities	Assets
(1) Shareholders Capital (being the money originally subscribed by the bank's founders)	(5) Government Securities
	(6) Other Securities
	(7) Notes
	(8) Specie
(2) Deposits	(9) Bills Receivable
(3) Bills Payable	(10) Mortgages
(4) Reserve	(11) Bank buildings

The totals of the two sides are the same the "reserve" being the apparent excess of assets over liabilities. We will discuss the items of this balance sheet one by one—

Shareholders' Capital.

This is the amount actually paid. It may be much less than the shareholders' liability if the shares are "partly paid" shares (see Chapter III). If so, the uncalled capital is an additional safeguard for depositors, but an additional risk for any one buying shares in the bank.

Bills Payable.

Bills drawn on the bank which will become due for payment in from three to six months from the time they were drawn (see Chapter IV).

It is generally the assets side which conceals the rotten spot in a bank's position if there is one. Items number 6 and 10 are the likely places.

Government securities.

It is very desirable that this should be the principal item. Government securities can be turned into ready money at any time with little or no loss.

Other securities

This item must exist. As we have seen, Government securities are not very profitable investments. But other securities should not be the ,principal item of the assets. "Other Securities" may mean any thing.

Notes and specie

Are quite safe and quite "liquid" ("liquid" means immediately avilable to pay any call on the bank). But money in this form brings no profit and therefore the bank cannot reasonably be expected to have much of its funds in this form.

Bills Receivable

These are bill drawn on other institutions or persons which the bank has bought for sums less than their face value (which it has "discounted"). Every one of these will become actual cash within a few months yielding a substantial profit on the money invested in them. A large proportion of the assets in Bills receivable is a good symptom.

Mortgages are as undesirable an investment for a bank as bills are desirable. Mortgages represent claims on real property. But the testing time of a bank is a time of panic, when credit has suddenly shrunk away to

nothing, and though the property is there, there are no buyers for it.

Forced realisation of real property under these circumstances invarably means heavy loss.

Bank buildings

No matter how palatial they are they should not figure largely in the balance sheet. Of all the banks' assets they are or ought to be the least liquid and should therfore be written down to a nominal figure very early in the history of the bank.

Insurance Companies

Deposits made in an insurance company are called premiums : are received at regular intervals, and in fixed amounts. It is not expected that the depositor will reclaim the money at any time before a pre-arranged date. He may under exceptional circumstances receive a proportion of it called "the surrender value" of his policy. An insurance policy is the written agreement between the insurance company and the depositor. With these exceptions the insurance company is a very similar institution to a bank ; that is to say, it receives the money of the public, and finds its profit in re-investing it.

But the idea of a person who deposits his money with an insurance company is quite different from that of the depositor in a bank. The latter wishes merely to have his money safely guarded. The former is providing against some possible but improbable accident. The

accident which is possible for a single individual will never happen to large numbers of people at the same time, and the insurance company is a kind of co-operative device for obtaining for the individual, as much as is possible of the certain destiny of the average man.

An insurance company may safely say to each of ten thousand young men all aged twenty. "Pay us Rs100 a year for the next thirty years, and when you have done so we will pay you Rs3000-0-0 and even more if we are fortunate in our investments. Moreover we will pay to your heirs the full Rs3000-0-0 even if you die next year. This is quite safe for the insurance company. Nearly all these young fellows will live to be more than fifty.

This kind of insurance is called Life Insurance, sometimes rather absurdly, Life Assurance. There is no assurance of life, but a young man may be assured in this way, that if he dies prematurely, he will leave as much as his more fortunate fellows. If he survives he will have to share with all those who survive with him the expense of providing for the few who die, but that is a trifling matter.

Investment in a life policy is essentially a young man's investment. During the first ten years of his career as an earner, he should take out a new policy in a different company every time he obtains an increase of salary. Never having learnt to spend the premium, he never misses it.

The balance sheet of an insurance company should be scrutinized even more anxiously than that of a bank. We need not recapitulate what was said in considering that. Except that there is no need for its assets to be as liquid as those of a bank, much the same applies. Panic does not affect an insurance company as it does a bank, but wars, epidemics, and disastrous fires do. Insurance should not be made in a company which does not average out such risks over a large area, which has not very large funds to cover them; or which has not a long history extending over at least a life-time. Those companies which collect premiums weekly should also be avoided. It is no doubt a convenience that some one should call regularly for the money, but it is a luxury too expensive for a young man.

Annuities

Just as an insurance company will insure a young man against living too short a time ; so it will insure an old one against living too long, which, though no young man will believe it, is a far more dreadful fate. (We do not mean of course, that it arranges to wring his neck as soon as he is past work). Its offer to another ten thousand young fellows each aged seventy or there-abouts takes this form ;—

" Give us that Rs3000-0-0 you got from us when you were fifty, and we will give you Rs25-0-0 a month as long as you live." Rupees twentyfive a month is ten per cent per annum on Rupees three thousand, much more than these ancients could hope to get from

any other form of safe investment. Moreover they are relieved from all anxiety for the future. Their daily portion of dahl bhat is perfectly safe even if they live to be a hundred. (Incidentally, they have relieved their heirs of the sin of wishing for their deaths and have made sure that they will be attended with anxious care to the very end). Neither is the insurance company taking any risk. It is quite certain that the majority of them will never live to get their Rs 3000-0-0 back again. The certainties of life are thus made to cancel out the uncertainties, and united humanity achieves yet another triumph over destiny and the grave.

Generally speaking an insurance company will insure against the risk of any accident which may, but does not usually happen. Against your house being burnt down; against total disablement; against being struck by lightning or by a meteorite; against being sued for damages by some person whom you have run-over with your motor car, against the damage to the car itself; against any liability you may incur for injury to your workmen under the Compensation Act, just as cheerfully as it will insure you against living too long or dying too soon. There are a number of financially powerful companies with experience extending all over the world, and over several generations, who know exactly what all these probabilities are and what premium they should charge in each case in order to insure a modest profit for their shareholders. A company which for any particular benifit offers to accept smaller

premiums than are customary is either inexperienced or is taking a risk. It should be avoided.

Appendix to Chapter VI.

AN INSURANCE COMPANY'S INVESTMENTS.

The directors of the Sun Life Assurance Society have taken the rather unusual course, for a company of its size and importance, of issuing a detailed list of all its investments. Not only are the various classes of securities indicated, but a list is given in handbook form, showing the exact amount held in each security, also the book value of each investment, so that the importance of the reserve represented by the difference between book values and present market quotations is evident. The total book value is £14,153,834 of which British funds represent £7,561,387. £958,000 War Loan 3½% has book value $91\frac{9}{16}$; £500,000 War Loan 5%, 98; £2,000,000 funding loan, 84; £2,236,000 Conversion 3½%, 72; £1,650,000 Conversion 4½%, 94. The market appreciation in all of these is important. A feature in regard to the society's investments generally is that except for the Conversion 3½%'s only £22,000 have no definite date of redemption. The list is well worth the study of individual investors. Having regard to the quality of the list, it is somewhat surprising that the society is able to secure an income, after providing for sinking funds in respect of terminal securities, equal to £4 12s. 10d. % p.a. after deduction of income tax. Practically all groups of securities are represented, in-

cluding even mines, nitrates, and oils, but in the three last-named securities held all are prior charges:—De Beers 4½% S.A. Exploration debentures, Antofagasta Nitrate, 6½% debentures, Lautaro Nitrate 6½% debenture, Anglo-Persian 9½% secured notes. All these are subject to redemption at definite dates." Cutting from "the Investors Chronicle" of 14-2-25.

CHAPTER VII

The Ledger

Whenever a business comes to grief it is almost invariably found that its books have been badly kept or have not been kept at all. Moreover it may be confidently asserted in nine cases out of ten, that it failed simply because its books were not regularly posted.

The reason is this. The healthy human mind is so constituted that it unconciously diminishes and forgets unpleasant things, while it cherishes and magnifies the pleasant ones. The pleasant thing in business is the income, the unpleasant one the expenditure. The man who trusts to his memory always forgets what he has spent as soon as ever he can, and remembers what he has received, and more than he has received indefinitely. With his mind in this balmy state it is only a matter of time before he burns his fingers.

The central sacred book of business is the LEDGER. It may be, and usually is kept in several different volumes called by various names, such as the "sales ledger" the "purchses ledger" "the cash book", and so on. Nevertheless they are all to be regarded as one book. All the entries recorded in this chapter are from one ledger only; namely the ledger belonging to R.N. Tewari.

Engineers should be familiar with Newton's third law generally translated from the Latin in which it was formulated as " Every action has an equal and opposite reaction ". In many text books, and by many teachers this is so expounded as to give the impression that it means that every force is accompanied by a sort of twin that stares it perpetually in the face. The real meaning of Newton's phrase is more accurately expressed by " There are two ways of looking at everything ". We say that the horse pulls the cart *forward* because that is our way of looking at it. The horse, however, if he could speak would say "I could get on much better if this wretched cart was not always pulling me *back* ". The stress referred to is the same in both cases. It is only the point of view that differs.

The useful applications of this principle (like many of the generalisations of genius, absurdly obvious and simple, once it is stated) are very numerous, and the engineer reader is doubtless familiar with many of them.

We are here concerned with the facts that every sale is also a purchase from the other point of view, and that every transfer of goods or money involves both a giving and a receiving.

Double Entry Book keeping—an Italian invention preceding Newton about two centuries, has as its central principle, the invariable record in the ledger of both aspects of every transaction; the giving in one place, the receiving in another.

We come here to another, and totally different meaning of the word "credit" used in previous chapters to describe that form of money which is essentially faith in the probity, and continued prosperity of a man: a business, or a nation. In book keeping a credit is the record of a giving, and the act of making the record is called "CREDITING". The record of the receiving which is the other aspect of the same transaction is called a "debit" and the act of making it is "DEBITING".

We will consider the very simple case of one R.N. Tewari who makes and sells one hundred cane bottomed chairs. In narrative or journal form his proceedings are as follow:—

He obtains on three months credit (note yet another subtle variation in the meaning of this overworked word);—

(1) Wood worth Rs.500 from A. Das and Co.
(2) Cane worth Rs.100 from P.Mitter and Co.
(3) Nails worth Rs.50 from M.Ganguli and Co.
(4) Screws worth Rs25 from „ „
(5) Glue worth Rs.2-8-0 „ „ „
(6) Varnish „ Rs.25-0-0 „ „ „

Having made the chairs he;—

(7) Sells them to S. Chakravarti for Rs. 1000-0-0.
(8) Is paid for them.
(9) Pays his own debts to the suppliers of his raw material.

The double entries of these events are as follow. Note that the openings (folios) of the ledger are numbered, not the pages, or rather that pages facing each other bear the same number.

Messrs Dass & Co. Ltd. (folio 1)

Dr.

1925		Rs	a	p

Messrs A Dass and Co, Ltd., (folio 1)

Cr.

1925		Rs	a	p
Jan 1st	By Wood	500	0	0

Goods Account (folio 2)

(This kind of account is called "Impersonal")

Dr.

1925		Rs	a	p
Jan 1st	To wood from A Dass & Co.,	500	0	0

Goods Account (folio 2)

Cr.

1925		Rs	a	p

Messrs P. Mitter & Co., Ltd (folio 3)

Dr.

1925		Rs	a	p

Messrs P. Mitter and Co., Ltd (folio 3)

Cr

1925		Rs	a	p
Jan 15	By Cane	100	0	0

Goods Account (folio 2)

Dr.

1925		Rs.	a.	p.
Jan 1st.	To wood from A Dass & Co.	500	0	0
Jan 15th	To Cane from P. Mitter	100	0	0

Goods Account (folio 2)

Cr.

1925		Rs.	a.	p.

Messrs M. Ganguli & Co.

Dr.

1925		Rs.	a.	p.

Messrs M. Ganguli and Co. Ltd.,

Cr.

1925		Rs	a	p
Jan 20th.	By Nails	50	0	0
,,	,, Screws	25	0	0
,,	,, Glue	12	8	0
,,	,, Varnish	25	0	0

Goods Account (folio 2)

Dr.

1925		Rs	a	p
Jan 1st.	To Wood from A. Dass & Co.	500	0	0
,, 15	,, Cane from P. Mitter	100	0	0
,, 20	To Nails from M. Ganguli	50	0	0
,, ,,	,, Screws ,, ,,	25	0	0
,, ,,	,, Glue ,, ,,	12	8	0
,, ,,	,, Varnish ,, ,,	25	0	0

Goods Account

Cr.

1925		Rs	a	p

Messrs S. Chakravarty Ltd.

Dr.

1925		Rs	a	p
Feb 28th	To 100 Chairs	1000	0	0

Messrs S.Chakravarty & Co. Ltd.,

Cr.

1925		Rs	a	p

Goods Account

Dr.

1925		Rs	a	p
Jan 1st.	To Wood from A. Dass	500	0	0
„ 15th.	„ Cane from P. Mitter	100	0	0
„ 20	„ Nails from M. Ganguli	50	0	0
„ „	„ Screws „ „	25	0	0
„ „	„ Glue „	12	8	0
„ „	„ Varnish „ „	25	0	0
	To Balance	287	8	6
		1000		

Goods Account

Cr.

1925		Rs	a	p
Feb 28th.	By Chairs to S. Cha' ravarty	1000	0	0
		1000	0	0

The Account has been "balanced" by adding the difference to the difficient side. If we were to go on with other items on a subsequent occasion we would begin with "By Balance Rs. 287-8-0" on the credit side. In this way we would carry forward our credit surplus. All the Accounts of a ledger are usually balanced once a month.

Cash Account

Dr.

1925		Rs	a	p
March 28th	To Cheque from S. Chakravarty	1000	0	0

Cash Account

Cr.

1925		Rs	a	p

S. Chakravarty & Co.

Dr.

1925		Rs	a	p
Feb 28th	To 100 Chairs	1000	0	0

S. Chakravarty & Co.

Cr.

1925		Rs	a	p
March28th	By Cheque	1000	0	0

On March 31st if he is an honest man, Mr. Tewari will send cheques to his three creditors; and if he is a good business man he will close the fairly satisfactory chair episode by crediting the cash account and debiting these gentlemen with the amount sent, in each case.

It is quite imperative that the reader should thoroughly understand this simple example. The method may seem cumbrous at first, but he will find with experience that it is the only sure and trustworthy method which will prove adequate to all emergencies. When it is thoroughly understood he may go on to ones more complex, and to the study of text-books dealing exclusively with book-keeping. In such books he will find many interesting variations and extensions on and of the above, but in no trustworthy book, any departure from the principle of double entry.

The accuracy of the ledger is checked at intervals by "taking out a trial balance." There are two ways of doing this; by 'POSTINGS" and by "BALANCES". Posting is a general term for debit and credit entries. The total credit entries should of course equal the total of all debit entries. This is the best and most thorough check.

In certain of the accounts taken singly, like the goods account above, there is a balance item. The total of debit balances should equal the total of credit balances. This is a quicker but not such a satisfactory check.

Theoretically a trial balance is no check at all. It appears to be quite possible to enter the debit and credit

of a particular transaction the same, but quite wrong on both sides, which of course would not prevent the trial balance from coming out perfectly correct. Actually, however, the trial balance is a powerful check, and that for more than one reason.

(*a*) Very often the different volumes of the ledger are kept by different persons. The credit and debit are very unlikely to be both entered wrong to the same extent by different persons.

(*b*) In the act of taking out the trial balance, every item is closely scrutinized, and therefore errors are likely to be discovered.

(*c*) The fraudulent clerk, or book-keeper, in his nervousness is almost certain to make some trifling error of a few pies. Wherever such errors are revealed by a trial balance there is ground for suspicion. The accounts in which they occur should be very carefully checked in comparison with the VOUCHERS. The "VOUCHERS" are the original documents on which the ledger is based. (See the next chapter).

But all the above falls to the ground unless an exact balance is insisted upon. There must be no "near enough" about a ledger trial balance.

Loose leaf ledgers must not be used. It is permissable and convenient to have other books of accounts of this type, but not the ledger. Every volume of it must be solidly bound so that it is impossible to remove a page without leaving traces of the operation.

Profit and Loss Account.

This is not one of the ledger accounts. It is an approximate document produced once a year with the aid of the ledger, but unlike it, having many of its items mere guess work, such as for instance the loss by depreciation of buildings and machinery. If the income shows a surplus over expenditure including dividends paid to shareholders or partners or if the expenditure is greater than the income, the difference is added to the deficient side as "Transferred to Capital account". It appears again in the balance sheet which will presently be described as "Transferred from Profit and Loss Account".

The Profit and Loss Account, if it fulfils its purpose, shows whether the business is prospering or not. It does not pretend to show whether it is solvent or not. That is reserved for the—

Balance Sheet.

The reader has already seen the balance sheet of a bank in an earlier chapter. The balance sheet of any business is constructed on the same lines; on the left under the heading "Liabilities" are shown all the business owes, including the capital subscribed by its founders, and on the right under the heading "Assets" all that it has. It occasionally includes among the assets such items as "Goodwill" which means the additional value of material assets, because they are assets of an established business enjoying the "goodwill" of a number of old customers, and "Patent rights". Both

of these may well be of great value, but the value may vanish in a few months. They are not satisfactory assets. They are the rotten spots corresponding to "Other Investments" and "Mortgages," in the balance sheet of a bank.

Auditing

There is no reason why the ordinary five eighths engineer should not be able to understand a set of account books honestly kept. But book-keeping is a skilled profession, and the dishonest book-keeper would probably succeed in throwing dust in his eyes. It is advisable therefore to have the books checked from time to time by an expert accountant. This process is called "Auditing".

The following Books are recommended for further reading :—"The Primer of Book keeping," "Book-keeping and Accounts" both by L. C. Cropper, are excellent straight forward text books.

CHAPTER VIII.

Auxilliary Books

The best known of these is the **Journal.** Many people think it an indispensable book, and as many others think it a useless relic of the now obsolete single entry system. It is as its name suggests, a day by day record of all transactions that take place. Ledger entries are copied from the journal.

It is undoubtedly an advantage to be able to see in one place everything that happened at a particular time, just as it is an advantage to be able to see in one place in the ledger all that happened with regard to a particular firm. But it is better to have no journal at all than to make it an excuse for delaying entries in the ledger.

The really respectable good old style English book keeper enters everything in the journal in order to study it and be quite sure it is right. He makes notes (in the journal) as to what ledger accounts should be debited or credited with particular items or parts of items. Having done this, he rolls up his sleeves to the elbows, fills his davat with fresh ink, gets a new pen, washes his hands three times, and proceeds to copy the entries into his ledger in the lovliest writing he is capable of. If he had the misfortune to make a blot, or a mistaken entry, he would rush madly from the office and probably destory himself. He very properly regards the ledger as the symbol of his honour and treats it accordingly

The Bank Book

is a copy of the firm's account in, the Bank's ledger. All the reader has to do with it is to keep it properly locked up in a different place from that where he keeps with the same care, his cheque book. The bank book is sent to the bank periodically to be posted up to date.

The cheque Book

is a book containing blank stamped and numbered cheques, also supplied by the bank.

The Order Book.

No. 99

Date

from

MESSRS A. B. & Co.

Benares.

To Messrs.

.....

Please Supply.....

.....

.....

.....

.....

(signed)

.....

No. 99

Date.....

from

MESSRS A. B. & Co.

Benares.

To Messrs.....

.....

Please Supply.....

.....

.....

.....

.....

(signed).

.....

Please quote above number in tendering invoice and account

The Order Book is like this. The order is made out in duplicate, and the right-hand copy is sent to the suppliers, the left or "counterfoil" remaining as a record. Alternatively the order may be written only once over a carbon sheet, but that is a sloppy method.

In a business of any magnitude the signing of orders tends to become a troublesome matter and the important and responsible officer who alone should have power to do it, is likely to find it a tiresome duty. Sooner or later some helpful person is sure to suggest a rubber stamp. The correct reply to this is "Get thee behind me Satan"

Very often each department of a big business has an order book of it's own, each with a distinguishing letter as A 99, B 99, C 99, Etc. The head of the department, or indeed any subordinate may fill up an order form. But only the Burra Sahib should sign either foil or counterfoil.

The {Bill / Invoice / Credit} Books. Except for the heading "Bill"

"Invoice" or "Credit Note" (the last usually in red) in conspicuous letters at the head, these three are practically identical in form and wording, and are in duplicate as the orders are. They each embody a list of goods, their prices, and any other information the merchant may wish to give his customer as for instance;—

Discount for cash payment.
Interest charged on overdue accounts.
How and to whom payment should be made.

"E. and O. E." meaning errors and omissions excepted, which is a way of saying that the merchant reserves the right to make corrections later if he discovers some mistake.

The invoice is sent when the goods are despatched. It is not as its wording would seem to imply a demand for payment. It is an intimation to the customer that he has been debited with the goods as Tewari debited Chakravarty with the hundred chairs in the last chapter.

INVOICE No. 67

Date.....

Messrs.....

.....

Dr. to Messrs. A. B. & Co.

Benares.

.....

.....

.....

.....

INVOICE No. 67

Date.....

Messrs.....

.....

Dr. to Messrs. A. B. & Co.

Benares.

.....

.....

.....

.....

E & O E

All payments Etc.

Except that the heading is "Bill" instead of "Invoice" and the number is different, the document which follows a few weeks later, probably at the end of the month, is a duplicate of the above. This time, however, it means "Kindly pay up"

In the meantime, however the firm may have returned some of the goods for some reason satisfactory to itself. It is not good business to refuse such returns from a good customer even though the reason may not appear very convincing. They are usually accepted, and a "credit note" is sent, which intimates to the customer that he has been credited with the goods, just as the invoice which would be more properly called a debit note informs him that he has been debited.

The Receipt Book.

Receipt Book

No.....

Date.....

Received from.....

.....

.....

.....

.....

Rupees.....

in $\frac{\text{full}}{\text{part}}$ payment of

Bill No.....

R.....a.....p.....

No.....

Date

Received with thanks from.....

.....

Rupees.....

in $\frac{\text{full}}{\text{part}}$ payment of our Bill No.....

anna stamp if Rs. 20 or over

R.....a.....p.....

The Burra Sahib initials the counterfoil and signs the foil.

Petty Cash

This is a fruitful source of income for the dishonest clerk, and requires careful watching. Petty cash means small sums for emergency expenditure. It is not possible to avoid it altogether, but unless carefully watched, it will grow and grow until it altogether supercedes the proper method of ordering formally as described above. The standing orders should include one specifying the maximum value of a single petty cash order, and another specifying the maximum monthly total of petty cash orders. Let us suppose the latter is Rs 500-0-0. This Rupees five hundred is the "Imprest Cash"

On first taking over his duties, the petty cash clerk is given his imprest cash, and at the end of every month the money he has spent is returned to him in return for his vouchers. A voucher is a written evidence that money has been spent on proper instructions. It is the duty of the office organizer to see that proper instructions are always given. A verbal order is not a proper instruction. A statement in the handwriting of the petty cash clerk himself is not a proper voucher. A V. P. P. cover without the initials of a responsible officer over the same date as the post mark is not a proper voucher.

If a messenger has to be sent into the bazar to purchase some trifle the following form should be used.

No.....
Date.....

To.....

Please Supply.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

For.....
.....

(signed)

No.....
Date.....

To.....

Please Supply.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

(signed)

No.....
Date.....

Received from
.....
.....
.....
.....

Rs..... ...a.....p.....

for.....
.....
.....

(signed)

Only the two inner forms are filled up. The two outer ones are torn off in one piece and go with the messenger. The merchant retains the central one and sends the outer one back with the messenger duly receipted.

Each departmental foreman may have one of these books. It should not be necessary to trouble the Burra Sahib every time a box of tacks or the like is required. The petty cash clerk should be instructed to advance money on sight of the two inner forms initialled by the foreman. It is his duty to see that he gets the receipt within an hour or two, and the change if any.

The petty cash book

may be kept in Journal form. The ledger should contain a petty cash account which should be credited every day with the amount spent "As per vouchers No. A 33, E 57, F 20 Etc." and debited once a month with imprest cash renewal. The debits corresponding to the petty cash account credits will be in various accounts. A bottle of gum for instance will be debited in the stationary account. The imprest cash renewal is credited in cash account.

The stamp book

is a journal record of all letters and parcels sent out, the addresses and the value of the stamps affixed.

In this chapter we have described the indispensable books of an ordinary business, and for the sake of a clear understanding, have given no alternatives. None of these forms is to be regarded as sacred. As far as the office

is concerned, however the list should be considered practically complete. It is a good engineering principle that a machine is none the worse for being simple, provided it fulfils its purpose. It is only the shallow minded that are impressed by a needlessly elaborate machine.

The purpose of an office organisation is to free the responsible head of all routine business, at the same time enabling him to trace every happening, together with the responsible person, no matter how much time may have elapsed since it did happen.

It is the first duty of the director of any business to rid himself of all routine work. Every detail of it should be entrusted to some subordinate with very clear, and exact instructions. It is the sure sign of a good manager that he never seems to have anything special to do, and has always ample liesure to attend to anything exceptional. It is the sure sign of a bad one that he is always busy, always distracted, and never has time to spare for anything.

There is one kind of business worse managed than that in which the manager does everything himself. It is that in which subordinates are allowed to adopt the apparently delightful and simple course recommended for the manager, and hand on their work to their subordinates. In that case the work is done or left undone by the coolies in the end. The manager should not do any routine work himself, but he should see that it is always done by the man he intended should do it. He

should be present and vigilant before the first employee arrives in the morning and should be the last to leave in the evening. He should not fuss about those employees who do their work properly. Where that is not the case he should inquire carefully, and without prejudice what the reason is. He will as often as not find that a good man is being turned into a careless one by having too much work elbowed on to him. In that case the work should be transferred to some one else. It should not be taken over either temporarily or permanently by the manager himself. When every man has as much work as he can do well, in a full day, and no more: then the manager can get on with his own work, which is the careful and continuous consideration of new developements and improvements.

CHAPTER IX

Choice of a Factory Site, and Buildings

The Site and Buildings influence all the work of the factory. Choosing a factory site is not only a matter of least initial cost. The proper choice is the first important step in the organisation, and lays the foundation for more profits and losses than the inexperienced would imagine. Taking it for granted then that there is an existence of favourable business or economic conditions for any particular enterprise and that the requisite funds for floating the concern are assured, the following things must be considered.

(1) Location of a site for the factory.
(2) Layout of the buildings and factory grounds.
(3) Design of Factory Buildings.
(4) Machines to be employed, their purchase and erection.
(5) Power plant for driving machinery, and full supply.
(6) Essential welfare conditions for securing a contented labour force.

1 Choice of site:—The first consideration we have then got to take up is that of the CHOICE OF SITE. The important factors playing their parts in the choice of a particular site for a particular factory or power plant may be enumerated thus :—

(1) Its location with respect to physical condition, labour supply, residential possibilities, transport connections, roads, connections with towns and future development.

(2) Facilities for power, water, lighting, and necessary atmospheric condition.

(3) Cost as regards size, taxation, future cost and future expenses.

(4) Isolation, to secure freedom from causing nuisance by noise, smoke, dirt, fuel and carting etc.

(a) Physical conditions:—

Although for small plants and factories the physical condition of the site is not of much importance, it is, in the case of a large scale concern. In those cases attention must be paid to the FOUNDATIONS of the proposed site and to the CONTOUR of the ground. For big power stations river-side sites are usually choosen and those sites are usually on alluvial flats ; so borings must be made to ascertain the nature of the substrata and their capability of carrying the heavier weights. Concentrated weights up to 15 tons per sq. ft. have to be arranged for ; as in the case of large stanchions to carry the dead load of the roof, over-head bunkers in the case of boiler houses, and the live load of the travelling crane. A good bed of stiff clay, or compact gravel—provided there is no underlying stratum of sand or peat—will make an excellent foundation. Sometimes in a site with alluvial soil or mud, owing to the other advantages to be mentioned latter, accruing

from the position, we have got to undertake the costly procedure of driving piles into the underlying subsoil and of floating a concrete raft.

In the case of big power stations care should also be exercised in FIXING THE DATUM LINE of the station. The relation to the water level of the condensing water supply, whether sea, river or lake, has to be fixed, especially in tidal rivers or estuaries. The limits of spring and ebb tides and of flood levels fix (a) the level of the condenser pipe line and (b) the levels of coal jetties and also of the engine room. Upon this depends the excavation necessary on the site and therefore the cost of the building to a certain extent. It will also have to be considered whether (1) the site is well drained and (2) whether there are facilities available to dispose of the drainage without creating a public nuisance.

(b) The labour question in the choice of a site, especially for a peculiar or special sort of manufacture, is of no less importance. The centralisation of industries helps a good deal in this direction because in the industrial centres there is always a good demand or market for skilled labour, and labourers knowing this always go there for jobs. Skilled labour is always available in such places. Special trades require labourers specialised in them, but those labourers are generally geographically segregated. It is an advantage to locate the factory where the supply is plentiful. This need not

necessarily locate the site in a town. A neighbouring district with efficient transportation facilities, or one with attractive local conditions may serve the purpose. The district should have a sufficiency of vacant property or enough room for developement, for with the growth of industry, the population of the area naturally increases. Thus a serious problem arises when the district outgrows its capacity for accommodation and the growth of the manufacturing area is stopped by the surrounding landowners. Given suitable residential areas however, and comparative nearness to a town, it is frequently possible to attract the best class of productive labour to an outlying district and yet have at the same time the town surplus always available through the railway or tramway connections.

(c) Residential Possibilities. There can be little question that consideration of workers' domestic amenities—as apart from bare necessities—ought to be an important consideration in the selection of a factory site. The point needs no sentimental stressing; suffice it to remember that not only do home conditions react on the intelligence exercised and the interest taken in the days work, but given congenial conditions at home and at work, there is a far greater inducement on the part of the worker to stand by their adopted employers to the advantage of both sides, by obviating the waste that arises from frequent change amongst employees. It is to the employer's interest to do his part towards making LABOUR become an intelligent constructive partner

rather than an ignorant destructive partner. Economic considerations need not stand alone and it is easier to give proper weight to labour conditions before selecting a site, than afterwards.

(**d**) **Transport:**—For large work or for works handling raw materials in any bulk and generating their own power the transportation facilities for raw materials and fuels must be duly considered. For works in an outlying district at any rate, a RAILWAY siding is a necessity for the efficient supply of coal and raw materials. For dealing with raw materials overseas it is judicious, if possible, to have the plant by the sea and in that case good wharfage becomes a necessity. In the case of small concerns, a district board ROAD APPROACH is a desirability. Also it must not be lost sight of in the latter case that the land going to be occupied for the factory building should provide a roadway link between the District Board road and the buildings. Owing to the oversight of this seemingly minor particular, it was found in one case that a factory building, for which a certain piece of land was acquired at a cheaper cost but at a little distance from the public road, many times the cost of the acquired land had to be paid, for linking up of the factory building with the public road, as the proposed roadway crossed the land of two or three other owners. The proximity to a public roadway does not only facilitate the transport of raw materials, fuel and the labour, but it also facilitates the conveyance of manufactured products to the

market. An extra mile of cartage cost is small in itself, but to add an extra mile of cartage cost to every load of goods inward and outward over a period of years represents a burden on production cost which no factory can afford. The HANDLING COST of the contractor in the construction of the factory is one of the first points to be considered. This is important, because an out-of-the-way site may entail an enormous amount of cartage that will eventually add more to the construction cost than the location would save in site cost. The nearer the site is to the source of raw materials and fuel, the less will be their transportation cost, and the nearer they are to the market, the less will be the freight charge for the products and therefore, the less their price. But it must also be noted that in most industries the raw materials have a greater bulk than the finished products, except in certain cases, their freight charge is a heavier constituent of the cost of the product.

On the other hand, under present tendencies, a WATER FRONTAGE will be increasingly valuable in the future for although water borne traffic is slow in transport, the economy affected in freight charge is a large factor. Also it serves as an alternative way for transport in case there is a railway strike or the land roadway becomes unusable (as it often does in Bengal) during the rainy season. In the rainy seasons some of the Tea gardens of Assam for instance, have to resort to boat-transport of their teas; because the kachcha roads to the neighbouring railway station deteriorate so much that

lorrey service becomes impossible. Canal facilities are of great importance when the the district is within convenient reach of and in direct communication with them, and with the probable reorganisation and development of waterways and canals the importance will be still higher.

Apart from the question of transport, proximity to water is extremely desirable for (1) an abundant supply of condensing water which effects great economy by dispensing with costly water condensing apparatus; (2) the provision of water, if free from hardness and corrosive qualities, for boiler feeding.

(e) **Local power and lighting facilities** will often affect the selection of a factory especially in the case of a small installation. In such cases the cost of production of power by their ownselves for their own purpose is, except in special cases, (like the utilisation of waste heat for local purposes) always greater than buying it from a bulk supply would be. Also in the latter case the dispensing with a separate power plant and its necessary attendants, improved and efficient methods of electric drive, largely reduce the production cost. Those districts, where there is a bulk supply of energy for power and lighting purpose, have a great advantage for the location of a factory site. In the case of big installations and out-of-the-way places, sometimes it is necessary to develop one's own power and in such case the supply of cooling and feed water is an impor-

tant consideration. In the case of large power plants it is of prime importance. Artesian wells are becoming more often sunk now-a-days for the water supply, where a river site or other public supply of water is not available or very costly. The quantity of water required for gas plants and steam plants may be as high as 9 gallons and 58 gallons per B. H. P. hour respectively in a Tropical climate like that of India.

(f)**Atmospheric conditions** have also to be taken into account very frequently in considering a factory site. Certain industries require special atmospheric conditions for their products and it will add greatly to the production cost if those conditions have to be produced artificially. Obviously, therefore, the district which provides these conditions naturally for the greatest period of the year, if only to a minor extent, lead to a reduced production cost, which in many cases is worth careful consideration. For the cotton industry a humid atmosphere is essential.

The considerations of COST OF THE SITE AND OF THE BUILDING cannot be entirely separated. As distinguished from transportation cost, we have the handling cost inside the factory building, which although it does not add to the prime cost of the building, indirectly influences it. For in order to minimise the handling cost, recourse is had to single-storied buildings which cover a large area of land and therefore involve a greater cost of site. The interest, on this prime cost sometimes

adds much to the running cost of the business. Also as has been already mentioned in the construction of a building in out-of-the-way places the construction cost becomes a heavy one owing to the cartage of the raw material of construction from a distance.

(g) **Future development** should always be provided for in deciding site. By building a new factory, surrounding land values should be increased owing to the additional population which the industry brings to the district. This increases the land value and therefore an investment in additional land will often pay in view of possible future development. In a populous district this may not be the case, as the estimated increased value may fail to pay a profitable interest on the additional capital involved. In a heavily populated district, where land is costly, a safe minimum of space may be the best to aim for. How this is utilised depends greatly upon individual requirements.

(h) Due regard must be paid in the case of **intramural sites, to local taxation, by-laws and regulations** e. g. restrictive regulations as regards heavy transport, by-laws as regards the construction of buildings all add to the running as well as the prime cost of the installation.

(i) Another consideration, which must not be overlooked, is : whether the site has within a convenient distance an **establishment for the repairwork** of the factory and for the other numerous aids which the business may call for.

Thus the **strategic location for the factory** involves a wide vision. It may be said that the place where the sum of the cost of raw materials, transportation of the same to the factory, manufacture (including the capital cost of land, buildings, plant, power, repairs to plants, cost of labour), the transportation of finished product and the final disposal of the same will total the smallest possible sum, is the most suitable. A great excess in one of these factors may neutralise advantages in all the others.

II Lay-out of building & factory ground :— When the adequacy of a site has been established and before the concern is committed to the site, a tentative plan of the general lay-out of the building and operations must be made.

A site having been provisionally agreed upon, it is necessary:—

(I) to examine the adequacy of the fund to meet the initial cost for that particular site.

(II) to have a clear definition of the quantity of finished product per week of 48 hrs. which the factory is required to give at the commencement of operations, and also the ultimate capacity to which it may build up.

This will give an idea of the number, size and character of the processes and of the number of men, machinery, buildings and quantity of power and ground area required. We may then proceed to the considera-

tion of (1) buildings, (2) machines and plant, (3) labour saving and economy.

The site being determined the question is now to make a lay-out plan of the building with due consideration to economy of handling cost, suitable accommodation for the various purposes of the manufacture and future development.

The single storied buiding entails a smaller handling cost no doubt. But this single storied building should not be disposed off in parts under different roofs, for it will lead to a greater cost than that of a building under one covered roof. The latter type of building should be preferred, especially for a small concern. The handling cost can also be minimised if the building is so designed that the materials during their process of manufacture have a unidirectional flow without crossing or recrossing their path, thus causing interference, muddle and delay. Thus the raw material should enter one side of the building and the finished product should come out ready for despatch from the other end. Road and transport facilities for the incoming and outgoing processes should also be provided for at the time of laying out.

The building should also be of such capacity as to provide accommodation for all the intermediate storage space during the process of manufacture and the storage space both for the raw materials (if covered space is a necessity) and for the finished product. The

Indian factories Act of 1911 as amended by the Indian Factories (amendment) Act of 1922 provides that (1) there shall be provided for each person employed at one time in any room of a factory where mechanical or Electrical power is not used, 36 square feet of floor space and a breathing space of at last 500 cubic feet, (2) where mechanical or electrical power is used there shall be provided for each person employed at one time in any room a breathing space of at least 700 cubic feet. Accommodation for the convenience of the labour should also not be lost sight of in the preliminary lay-out. Thus ample room should be provided for lockers for workmen's clothing, their meal-rooms, office for staff etc. If the factory generates its own power, room should be made for it in its convient position in the building

Facility for Extension. Every industry is of course expected to thrive and therefore ample room on the site should be left for additional building for future development. Otherwise the original building will be overcrowded by men, machinery and products. The best method to relieve this congestion is to lay-out the first building in such a way that the additional requirement of room, either for a part or whole of the process can be best met by duplicating or extending the building without interfering with the main channel of material flow through the factory: or in other words the main direction of the progress of work and the flow of material should be at right angles to the direction of development.

The actual sequence of departments from receipt

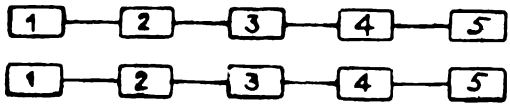
of material to the despatch of product is a matter of great importance calling for very careful consideration. Similarly the geographical relation of the terminal points reacts on administration. A strictly straight line system may not therefore be as sound in practice as a horse shoe arrangement with external traffic control brought together, both as to goods received and goods despatched, in one area. For instance a railway siding will probably be best placed across the poles of the horse shoe, serving both stores and warehouses.

The best arrangement is to have the offices and stores at the entrance with sufficient provision to ensure that all persons and goods shall only be able to enter under close survillance. The Engine and boiler houses should be parallel to one another and should be behind the offices.

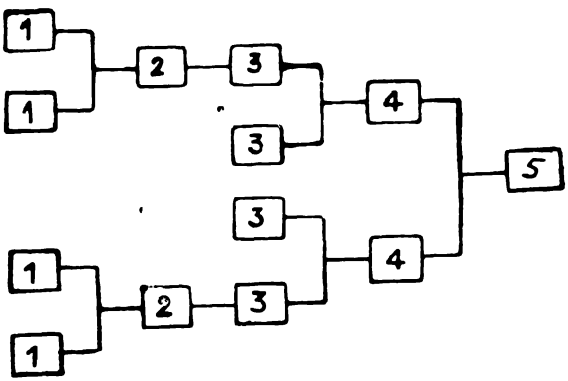
The plan of the building being settled the laying out of the machines and plants should now be thought out. The machines should be arranged in direct sequence to the operation ; so that the flow of material from operation to operation should be as direct as possible. The lay-out of the machines of course depends upon the particular industry and its special conditions. The following are some of the usual arrangements to be preferred :—

(i) Where the material, as in jute, paper, saw mill and box plants flows from one end of the building to the other the machines may be arranged in simple sequence thus :—

(ii) Say in a button factory, there are similar processes but on different materials—so the arrangement here takes a 'parallel sequence' system thus :—



(iii) As in an Engineering Workshop, where the process of manufacture involves several auxiliary operations or the combination of several components ultimately to be combined into a complete article, the arrangement takes the form of an 'assembly or tributary sequence' thus :—



Cases may arise where none of these systems is strictly applicable, but satisfactory arrangements can always be made if the guiding principle is adhered to.

The buildings should be such that every department can be extended without duplication. A small building on these lines is just as cheap and more valuable even in liquidation.

The Factory as a whole should have only one exit for work people which should also be the entry. Exits or entries for goods should be closed at least an hour before stopping time.

But no workshop should have only one entry. The workman should not be able to watch BOTH doors at once.

It will be required to provide in general :—

Power House— close to road or rail and to water supply.

Foundry— next in proximity to road or rail.

Smithy— next

Machine Shop— do

Store— do

Offices— including Drawing Office. do

In the Northern Hemisphere light should be from the North side.

The Pattern Shop may be above foundry and the drawing office which must have good light above administrative office. If the power transmission is by rope

or shaft the machine shop should adjoin Power House. The boiler, if there is one, should be within its own walls.

If French trusses are used, the building must run East and West and get light from north wall ; 75% of wall should be window.

If it is unavoidable that the long way of the building is N. & S., the roof should be saw-tooth with vertical windows facing north.

This type of roof is of growing popularity. It looks well from the railway, and VERY WELL in a photo as one building looks like many.

The machines should be arranged as described above but they should not be congested. Ample room should be left for the erection, dismantling etc. of such machine and also for its contingent material service. For the latter the final position of a piece of work or a machine product at the conclusion of an operation serves as an initial position for the next operation. Thus as far as possible to minimise handling cost, the level and position of each machine should minimize human labour in lifting against gravity in its service, and facilitate the direct flow of material. Also the batches of machines engaged on different components or stages of manufacture should be separated by alleyways and the necessary space required for intermediate storage of semi-manufactured material, where necessary.

An important question that often interferes with planning is that of power. Where the power is great, a

considerable amount of waste must occur if heavy machinery is located at a distance from the main drive. This question generally arises where the power is to be transmitted by shafting only. Occasionally it happens that, for this reason the power plant has to be situated in the middle of a factory. It is desirable, as far as possible, to shorten the power drive, to avoid angles and multitudinous counter-shafts. When the distance is great or the arrangement of departments militates against efficiency in this respect, a considerable saving can be effected by the use of motors, either departmentally or for each of the heavier machines.

Due consideration must also be paid to the heating, lighting and ventilating of factories.

At the time of planning a factory due consideration must also be paid to the fulfilment of the Factory Laws and other conditions for the welfare of the labour and economy. Thus for a factory where there is enough of women labourers a room may be left for the nursing of the children of the mothers employed or as a day-nursery for children who cannot be left at home. There must also be a suitable meal room, and sanitary and washing accommodations for the workmen Facilities for interviewing applicants for employment, the payment of wages, accident treatment, time recording and gate control ; and general offices should be provided for near the works entrances, and a decently furnished room for receiving important visitors, Committee meetings and the like.

Accommodations for clothing, umbrellas, bicycles, and space for protecting and drying outdoor clothing in wet weather should not be overlooked.

Buildings:—Buildings are necessary for protection from weather and also to ensure as far as possible uniform conditions of temperature, lighting, humidity and air circulation; and also for the protection of plant and meterial from theft. Thus in a tropical country like India where the sun is so strong, to make provision for the avoidance of incidence of direct sun-light with its consequent glare and heating effect in the buildings, it is better to have the buildings layed-out with their **length east and west**. Sufficient lighting is obtained from windows on the northern wall. Cases may arise where it is not possible to get the building running east and west; then the same effect can be had by adopting the SAW TOOTH roof paterns with windows facing north instead of the ordinary truss-shaped roof. Often the former type is preferable. For in the case of widths too big for single span buildings, multiple spans of 20-25 ft. are adopted with saw-tooth patern northern lighting together with windows on the northern wall.

Although single storied buildings do not make the Economical use of the land area they cover,and the double storied buildings do, yet, as has been shown, they reduce the handling cost. To this we may add the advantages of better lighting, ventilation, less vibration, cheaper foundations, and a smaller building cost generally. The length and width of the building must be sufficient, on

doubt, to accommodate the machinary in their proposed order of arrangement, but on the width depends the cost of the roofing and therefore of the building. Also the greater the width of the building in the case of absence of roof-lighting the higher must its ceilings be to provide for higher windows for adequate lighting at the middle of the floor. The question of height of the building is also affected largely by the provision for overhead cranes or heavy shafting etc.

Due considerations must also be paid to the carrying away of rain-water from the roof of the building. The plinth of the building must also be high enough to be dry and also to be safe from inundation by rain-water from heavy showers etc.

The ventilation of the building is an essential factor in its design. In our country India complete control of air conditions with respect to temperature, humidity and quantitative rate of change, is not possible without adopting mechanical means involving considerable expenditure. However, such natural ventilation as is possible can be secured by designing the roof in such a way as to have a direct opening to the outside air, properly protected from the elements and preferably on the northern aspect of the building.

The last point we have got to consider is the ECONOMICS OF THE BUILDINGS with respect to their materials of construction. The whole of the Buildings should be as fire-reserting as it is possible to make them. The buildings may be of brick, combination of brick

and steel, re-inforced concrete or steel frame and metal enclosures.

In localities where bricks are easily available, the adaptability of brick construction and its rapidity of erection in one storey, shops of large area, commends them as being the most suitable and economical material. The long walls may be easily stiffened by steel piers or stanchions where extra strength (other than that for supporting the steel roofing structure) is required.

The combination of steel and brick for buildings has the same advantage as above with the additional merit of allowing the shops to be divided into any number of bays, the partition walls of concrete slabs gaining their strength from the steel stanchions and roof girders, and being rapidly and economically erected.

Reinforced concrete is also largely used. In out-of-the-way places, such as in the hydro-electric power station buildings, where the ballast usually costs nothing and freight charges for large and heavy girders are high, the economy of this method of construction is self-evident. But one disadvantage of these buildings is that they cannot be adapted, unless provision is made at the beginning, to purposes other than that for which they were constructed.

The last method of steel frame and metal enclosures (usually corrugated iron) is only used as a temporary means for emergencies. The great disadvantages are that the up-keep of these buildings is high and it is

difficult to keep the temperature constant in these buildings. In Urban districts special sanction has to be obtained for them.

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CHAPTER X

Choice of a Source of Power

The modern tendency is towards the concentration of power production in large central stations either generating from coal fired boilers and steam turbines or from natural water power in those districts which are fortunate enough to possess it. Where such a source of public power supply exists, and offers unlimited power or rather far more power than the factory is likely to need at, say, not more than two annas per kilo-watt hour, there is no need to consider a private generating plant ; unless, of course the concern is of a magnitude comparable with the central station itself. The advantages of the public supply for comparatively small works are :—

(1) All available space and capital are available for the prime purpose of the factory.

(2) No managerial ability is required in connection with the power supply, electrical transmission to small isolated moters being about as fool proof a method of power distribution as there is.

(3) Greater reliability. (Because a large central station can afford to employ the most expert, and scientific management).

(4) A considerable reduction of "banking losses" which are losses due to the plant being shut down or

partly shut down. A central station in an urban district commonly has an outlet for much of its power in street and house lighting during the hours when power is not required for industrial purposes. It may transmit some of its banking loss to consumers by means of a differential tariff, that is to say by charging more in the day time when loads are heavy, but the extra cost is not as great as it would be in a private station.

The choice of a prime mover will therefore have to be considered only if :—

(a) there is no public power supply at a reasonable rate.

(b) the factory process is one requiring heat for purposes other than power production. All heat engines waste great quantities of heat, which may occasionally be made use of for various purposes.

(c) the factory process involves the production of cheap fuel as a bye product which may be used to generate power privately, either by means of gas producers or steam boilers.

If any of these conditions exist a choice must be made among the following :—

Steam Engine, and boiler.

Oil Engine.

Gas Engine.

Water power.

We shall now consider these in detail in the order given.

Turbines.—

Occupy much less space than reciprocating engines and are simpler in mechanism but their condensing equipment must be more refined to suit the high vacuum if the turbines are to work efficiently. For powers higher then 2000 K. W. the steam turbine has ordinarily no competitor except in districts where water power is readily available for commercial uses. But small and medium power turbines from 500 to 2000 K. W. do not compare favourably with reciprocating engines and are not so economical as steam engines in fuel nor so reliable. But low pressure turbines are often used in connection with existing reciprocating engines. Another drawback of the turbine is that it requires highly skilled attendance and its repairs are difficult. For units more than 2000 H. P. capacity the steam turbine will usually prove the most economical and above 800 H. P. capacity the turbine will cost somewhat less than the engine.

Horizontal Mill Engine.—

The modern high class mill engines fitted with corliss or drop valve gear installed with proper auxiliaries is one of the most reliable and durable power plants up to 2000 B. H. P. The reciprocating steam engine is very economical for small plants having from 1 to 3 units of not more than 500 H. P. each.

Vertical High-speed Engines.—

This type of engine occupies a smaller floor-space but greater head room than the horizontal type and is slightly more efficient on account of the higher speed at which they are usually run.

The Uniflow Engine.—

This engine has a high efficiency. It occupies less floor-space than a corresponding tandem compound horizontal engine and its maintenance cost is smaller. In this engine there are only one cylinder and piston instead of a number as in a compound engine and the large exhaust parts allow a higher vacuum to be made use of.

Locomobiles.—

The engine boiler and all the auxiliaries being combined in one unit they occupy a much smaller floor space than any other steam engine. The foundations are simpler. The cost of upkeep is smaller, and the whole plant is more compact than any other type. The boiler offers a great facility of inspection, its cleaning is simpler and the reliability of the whole plant is very considerable. But they are slightly more difficult to repair. On the whole the locomobile is much superior to the separate engine and boiler for powers up to about 350 B. H. P., and banks of these engines have been installed for larger powers with success.

Internal Combustion Engines.

Producers and Gas Engines.—

Gas engines working in conjunction with producer gas, i. e. either with suction or pressure gas plants are very efficient where fuel is concerned, and in cases where waste material, such as wood chips and sawdust or leather cuttings can be utilized there is a considerable reduction in the running costs. As auxiliary, the gas plant has no superior, the stand-by losses are less than for steam plant and the smoke nuisance is eliminated. Waste gases from blast furnaces are utilized with advantage for running gas engines although it is necessary to install a gas purifying plant to thoroughly clean the gas before it is burnt in the engine. Small gas engines run by suction gas plants from 20-100 B. H. P. are very efficient. Engines burning town gas can be quickly started and are very reliable. They are most suitable for intermittent work but usually above 200 B. H. P. it becomes too expensive to run gas engines by town gas.

Diesel Engines.—

Regarding fuel economy it is the most efficient prime mover at present on the market. Engines of this type have now been made up to 10,000 B. H. P. with considerable success.

The main disadvantages of the Diesel Engines are :—

(1) Its high initial cost.

(2) Its high maintenance cost, and

(3) The comparative expert attention required for driving.

Semi-Diesel Engine.—

This two-cycle engine has about 8 to 10 per cent lower thermal efficiency than the Diesel Engine.

The oil engine plant is very simple in construction, ready for instant service without stand-by losses ; it causes, no smoke, dirt or dust nuisance and it requires the minimum amount of operating labour.

Its disadvantages are that its installation and repair costs are high and very large units are not yet available.

ECONOMIC LIMITS BETWEEN WHICH PRIME MOVERS OF THE VARIOUS TYPES MAY BE ADVANTAGEOUSLY USED —

Table I.— Economic Limits For Prime Movers.

Type of engine or motor.	Power limits within which the type may be practically employed.	Normal consumption per horse-power-hour at full load.	
	H. P.	Steam, lbs.	Fuel, lbs.
Stationary steam engines :—			
Slide-valve, non-condensing ...	15 to 50	37.5	5.5
Slide-valve, condensing	30 to 100	22	3.3
Corliss or Sulzer, simple condensing	50 to 200	17.5	2.5
Idem, compound	80 to 1000 and upwards.	13	1.85
Semi-portable steam engines :—			
Simple, non-condensing	20 to 50	16.5	2.4
Simple, condensing	40 to 80	13	1.9
Compound, condensing	60 to 300	9.5	1.35
Triple-expansion, condensing with superheater ...	300 to 500	7.6	1.1
Steam turbines condensing ...	500 to 1000 and upwards.		

Type of engine or motor.	Power limits within which the type may be practically employed H. P.	Normal consumption per horse-power-hour at full load.	
Internal-combustion motors: Illuminating gas ...	1 to 30	17 50cu.	ft.of gas
Oil	1 to 20	0 75	lbs. oil
Producer gas, suction	115 to 300	0.88	„ coal
Producer gas, pressure ...	100 to 1000 (and over).	1.00	„ coal
Diesel ...	50 to 5000	0.42	„ oil

The limits indicated above of course are not absolute. Many small steam engines with vertical boilers are in use, for example, in units of very few horse-power each.

Hydro-Electric Plants.

Next we come to hydro-electric plants, and it may be stated that a central steam electric plant cannot compete with a normally conditioned hydro-electric plant.

The most important points for **consideration of the economic basis of a hydro-electric plant** against a steam design are the following :—

(1) The location of raw materials with reference to the power, the distance to the market, and transportation facilities.

(2) Quantity of available power and how far the power supply is reliable, continuous and regular. If the flow is variable it must be supplemented by steam or other power.

(3) The cost of development of the water power including the building, business plant, the charges for interest, insurance, taxes, deterioration and repair cost. The cost depends upon the head, the quantity of water and uniformity of flow during the year.

(4) If the process of manufacture requires steam for use and the quantity of steam necessary as in textile mills.

(5) Cost of transportation of products and of supplies.

(6) The total operating cost of the water power plant at a given place as compared to that of a steam plant erected at a more advantageous place.

(7) The opportunities of obtaining good employees.

The chief conditions affecting the cost of water power are:—

(1) The fixed charges on the development.

(2) The quantity of power produced in its relation to fixed charges.

(3) The load factor in its relation to the efficiency of the wheels, poundage and reservoir capacity.

(4) The cost of supplementary power necessary to make up for the fluctuation of the water power.

The depreciation in water power plants will range from $1\frac{1}{2}$ to $2\frac{1}{4}$ % per year, repairs 1 %.

In general to make the final selection the following points should be carefully compared :—Reliability of Operation, Fuel Economy, Capital Outlay, Available Floor Space, Flexibility and Overload Capacity, Maintenance and Repair Costs, Ease of Starting, By-products, Depreciation, Water and Lubrication Oil Consumption.

For final selection of the prime mover, Reliability of operation is considered to be more important than fuel economy. If reliability is sacrificed to fuel economy and if a set shuts down due to an unreliable prime mover, there would, in all probability, be a greater loss due to the shut down than a few per cent. saving in fuel would balance. In this respect steam engines have no competitors. Small horizontal gas and oil engines up to 100 B. H. P. do, however, compare very favourably with steam plant of the same outputs. Internal combustion engines are as a rule somewhat erratic in their performance where reliability is concerned, and considerable trouble is often caused by their shutting down or failing to develop full power, due to hidden causes. This is rarely the case with the normal steam engine which will run consistently for years with very little attention. The sudden stresses set up in the reciprocating parts of internal combustion engines specially if it be one of single cylinder are more liable to cause serious breakdowns than is the comparatively smooth running of a steam engine.

The available floor space is sometimes a deciding factor in the choice of primer mover. The Diesel Engine occupies less floor space than any other prime mover of the same capacity, and of the steam Engines, the locombiles deserve consideration.

With regard to flexibility and overload capacity the steam Engine is vastly superior to any internal combustion Engines: while the former is generally capable of taking an overload of 25 to 75 % of its full capacity the latter can hardly deal with a 10 % overload and that also for comparatively much shorter periods. While producer gas plants are extremely unsuitable for running on varying loads, a steam Engine would readily answer to any kind of load variation.

Thus we see that before a final verdict may be given for the choice of any particular type of prime mover for a place, all the avilable information with regard to the geographical position of the place, the kind of work that the factory is to undertake and the extentions that are likely to be made even in the future are to the thoroughly considered. But as a main guidance we may summarise that suction, gas or oil engines are cheapest for outputs up to 100 k. w., for higher outputs up to 400 k. w., the "locomobile" steam-boiler and engine can hardly be beaten for convenience and economy, though it has keen competitors in the Diesel and semi-diesel engines Similarly for outputs from 500—1500 k. w. the uniflow and Lentz engines are rivalled closely

by Diesel and semi-Diesel engines; with cheap oil the latter would be at a considerable advantage. Up to 100 k. w. there is no advantage in using turbines rather than reciprocating steam engines. For outputs exceeding 1000 k.w. the steam turbine is generally the most economical prime mover, but large gas engines can be used with advantage where coke-oven or other cheap gas is avilable, especially if the annual load factor is high, say 50 °/₀ or over.

The steam engine has the advantage that it is more reliable and its running is simple and may be entrusted to comparatively inexpert labour. Its initial cost is low. But the fuel cost of small engines is notoriously high; it may go from 10 lbs. to 20 lbs. per B. H. P. hr. So when the coal consumption (2—5 lbs. per B. H. P. hr.) of big steam driven power stations are compared with that of these small stations, the waste involved therein is obvious. The preferable type of steam prime movers are either the locomobile or vertical high-speed engines. Regarding the boiler for such small plants it may be said that its thermal efficiency in ordinary use is pathetically low and this becomes more so when the boiler is being worked by comparatively inexpert labour, as is usually the case in our country. These inefficiently fired boilers are not only economically bad but the dense smoke given out by them when worked inefficiently becomes a public nuisance. Thus a small steam engine with its boiler apart from its reliability, simplicity and flexibility of operation has little to recommend it.

Again the steam boiler requires soft, clean water for its feed water, so the site for such a plant is restricted to localities where such a quality of water is avilable. The question of coal for the boiler binds it to be near a railway siding or a place having water and coal transport facilities. But where the coal is cheap and readily obtained or there is an economic outlet of the waste steam for purpose other than power, the steam plant is undoubtedly the best to adopt.

Thus it is seen that except in the especial cases mentioned above, the balance of advantages and disadvantages weighs emphatically for the use of internal combustion engines as the prime movers most suited for small power capacities. The great disadvantage of these prime movers however are that their working cannot be entrusted to unskilled labour and that their initial cost is high and their repairs cannot be done in an ordinary workshop, so that in an out-of-the-way place, the repairing of any vital parts may lead to a great delay and increased expense. But its compactness, adaptability and general convenience place it far ahead of the steam engine with its necessary boiler, fuels, chimney etc. and engines of this type are now-a-days available in sutable standard sizes from 1 h. p. to 100 h. p. or over.

Now the problem of alternative choice of an oil, a gas or a suction gas engine, depends largely upon the locality. In the vicinity of a public supply gas work or near iron and steel factories, the gas engine will

undoubtedly be the suitable prime mover. Whereas in a place where the coal, for the producer, is difficult to get, and the cost of oil is not prohibitively high, the oil engine suits the situation. But if the factory enterprise is one that produces a combustible waste product in sufficient quantity, such as spent tan, rice husks, saw-dust etc. a suction gas plant using this waste product is undoubtedly the most economical and the best plant to adopt. But in a case where the coal is available and the oil is costly and where there are difficulties regarding water supply which prohibit the use of a steam engine and boiler, a gas plant using slack coal, is worth consideration. But in every case, before the choice is finally made it is better to prepare an estimate of the fuel, labour, lubrication, stores and repair charges for each type of prime mover and add to this the capital charges for individual cases. The minumum sum per K. W. will indicate the suitable prime mover to be adopted.

In calculating the fuel cost per kilowatt hour several important items are to be considered and the cost may be mainly divided into the two following divisions, viz. :—

(1) Capital costs, consisting of interest to be paid on the capital, and depreciation of the plant.

Generator prices, deduced from Burton's catalogue (1923).

Lancashire boilers with all mountings but without brick work. Price in rupees, 50 H. P. + 4500 ; 160 lbs. pressure, 30 lbs. per H. P. hour.

Slow speed horizontal steam engines up to 400 H. P. simple and compound without condenser; R = I H. P. × 75.

Condenser and pumps allowing 30 lbs. per H. P. hour. Price in rupees, R = 20 I H. P. + 3000.

Oil Engines (Non-Diesel) up to 300 H. P., R = B. H. P. × 180.

Suction gas producer (waste products—not anthracite) up to 250 H. P. ; 160 B. H. P. + 7500.

Steam electricity generating sets (engine & dynamo)

Up to 300 K. W.

R = 150 × K. W.

Oil generating sets up to 20 K. W. ; price in rupees is 750 K. W. 20 to 300 K. W. ; price in rupees is 150 K. W. + 7500.

The following is approximately true of a steam Engine :—

Total Coal in lbs. per hour = 2 I H. P. + 400 (A)

or Coal per H. P. hour = 2 + 400/I H. P. (B)

The corresponding equations for Crude Oil Engines are —

Total oil in lbs. per hour = 0.45 I H. P. + 2.5 (A')

or Oil per H. P. hour = 0.45 + 2.5/I H. P. (B')

These equations mean that for small horse powers the Oil Engine is much cheaper to run, but that over 100 H. P. the higher price of oil may counterbalance the small consumption.

Example.—If the price of coal is Rs. 15 a ton and of oil is Rs. 75 a ton, which type of Engine will cost less for fuel at 10 H. P. and at 5000 H. P.

at 10 H. P. $\frac{\text{coal costs}}{\text{Oil costs}} \frac{420 \times 15}{7 \times 75} = \frac{420}{35}$.

The Oil Engine is much cheaper to run

at 5000 H. P. $\frac{\text{Coal costs}}{\text{Oil costs}} \frac{10400 \times 15}{22525 \times 75} = \frac{2080}{2250}$.

The Steam Engine costs less to run by 10 per cent (two in twenty). This means a saving of Rs. 16000 per annum in cost of fuel.

Example.—Which would be the cheaper at 400 H. P. allowing for Capital cost. Fuel prices as above, say generating sets for both and boiler and condenser for steam.

Capital cost of steam plant is 95,500. We will allow one-fifteenth for depreciation and 5 per cent for interest on this, say Rs. 11,000 per annum.
Coal at Rs. 12 per ton will come to Rs. 14,400.
Total annual cost for steam Rs. 25,400.

The oil generating set will cost Rs. 52,500. We will allow 10% depreciation and 5% interest.
Annual cost Rs. 7,875-0-0 per year.
Fuel cost Rs. 12,025 per year.

The Oil Engine has much the better of the comparison, and this will in general turn out to be the case up to two or three thousand horse power. But the important and uncertain factor is the price of oil. At the present moment Oil Engines are cheaper to run up to two or three thousand horse power. The world's supply of oil, however, is being prodigally expended and in the absence of great new discoveries it is practically certain that the next decade will see famine and famine prices. On the other hand we have supplys of coal for Centuries.

(2) Working Cost, consisting of :—Cost of fuel per kw. hour ; cost of oil, water, etc. ; cost of labour ; cost of repairs and maintenance ; management expenses, etc ; income from by-products.

If we suppose the managing expenses to be approximately the same for all classes of prime movers and the load factor is assumed to range from ·2 to ·28 the following tables would indicate the comparative costs of fuel per kilowatt hour.

TABLE—I.

COST OF FUEL.

1 Type of prime mover.	2 Fuel.	3 Average cost per ton of fuel in shillings.	4 Average lower cal. value of fuel in B. T. Us. per lb	5 Average overall thermal efficiency of prime mover per cent. including boilers or producers.	6 Average costs for fuel in pence per Kw. hour.	7.
Diesel 50-250 B. H. P.	Crude oils	250	18300	26	·97	
	Tar oils	150	16000	26	·67	
Gas engines suction gas producer (Up to 200 B. H. P.).	Anthracite	80	15120	17	·67	Assuming producer efficiency of 80 percent.
	Coke	30	12500	17	·28	
Gas engines pressure gas producer (100—1500 B. H. P.).	Commercial coal	45	14000	21	·28	Assuming producer efficiency of 80o/o.
Gas engines producer and recovery plant.	Commercial coal	45	14000	6	·17	Allowing 70 per cent. income from by-products but 12 per cent. decrease in thermal efficiency due to recovery plant.

TABLE—II.

COST OF FUEL.

1	2	3	4	5	6	7
Ordinary Steam Engine (100—1500 B. H. P.).	Commercial coal.	45	1400	13	·455	Assuming boiler efficiency of 75%.
Uniflow and Lentz (100—1500 B. H. P.).	Commercial coal.	45	1400	14	·43	Assuming boiler efficiency of 75%.
Locomobiles (100—350 B. H. P.).	Commercial coal.	45	1400	15	·395	Assuming boiler efficiency of 75%.

If the Steam Power has been selected the next problem is to decide what type of Boilers should be used.

Choice of Boilers :—

The selection of the type and size of the boilers to be used in a particular locality for a particular purpose should be made with judicious care after weighing the pros and cons of the various factors involved.

There are two main classes of boilers :—

(1) Drum fire tube,

(2) Water tube.

The former comprises various types of which the following are commercially successful :—

(a) Vertical simple or multitubular boilers.

(b) Lancashire boilers.

(c) Dryback marine type.

(d) "Galloway" type.

(e) Locomotive type.

And the water tube comprises the following types :—

(a) Straight tube boilers of which "The Babcock and Wilcox" is the best known.

(b) Bent tube boilers.
The "Stirling" boiler is the best known of this type.

(c) Marine type water tube boilers.

The following are the factors which are to be taken account of in selecting the type of boilers :—

(1) Capacity of plant to be supplied with steam and the steam consumption per K. W. H.

(2) The quality of fuel and feed water.
(3) The nature of the load.
(4) Floor space available.
(5) Accessibility for transport of materials.
(6) Durability and simplicity of design.
(7) Facility for management and labour available.
(8) Efficiency and economy of running cost must be considered along with the initial capital outlay.

The measure of the capacity of a boiler is heating surface and evaporating power and the sufficiency of these to provide a given H. P. in an Engine depends on

(1) The Type of Engine.
(2) On the class of the Fuel used.
(3) On the Draught available

The type of valve gear and the working pressure will materially affect the steam consumption per I. H. P.

(1) The maximum output of the Drum boilers i. e. Lancashire and Dryback marine type is limited in consideration of their drum becoming of unwieldy sizes. The maximum output is limited to 500 H. P. in case, of non-condensing engines, to 600 H. P. for condensing engines. It can be increased to 20 °/₀ more in case of Turbines.

In the case of water tube boilers the output is 6250 H. P. when used with turbines. They allow of such a high output due to their being made in sections and none of the individual parts being too heavy or bulky.

Steam consumption per K. W. H. can be ascertained with sufficient accuracy from the following :—

Single cylinder non-condensing uses	30-40lbs.	/I. H. P.
Compound non-condensing	25-27 lbs./	hour.
Compound engines (condensing) ...	18-20 lbs./	„
Triple expansion (condensing) ...	12-15 lbs./	„
Large size steam turbine ...	11-13 lbs./	„

For economic working and to avoid priming when boiler is subjected to overloads an ample supply of steam should be provided. Generally about 50 % more than calculated above is provided in the case of Drum type boilers. Boilers are rated by their normal evaporation from and at 212°F.

(2) Having determined the total quantity of steam required for power we can approximately determine the grate area required. The qualtity of fuel has much to do with the quantity of fuel that can be burnt per sq. ft. of grate area and the quantity of water that can be evaporated per lb of coal.

The Indian coal available in the market having a calorific value of 11800 B. T. U. can be burnt 15 to 20 lbs. per hr. per sq. ft. of grate area in drum types and about 22 to 25 lbs. in water tube types. The water evaporated per lb. of coal depends upon the quality of the coal and the efficiency of the boilers generally about 10 lbs. of water are evaported per lb. of coal of above quality in Lancashire boilers and 8 lbs. in case of water-tube boilers. Dryback marine boilers fitted with economisers often approach the efficiency obtained by water tubes.

Note—that the average calorific value of British coal is about 14000 B. T. U. so in calculating the capacity a proportionately increased size will be necessary in India.

Drum type boilers are adapted to bad water as they can be easily cleaned while the water tube types are not well adapted for use with hard or corrosive water.

(3) The nature of the load determines partly the type of boiler to be used. Boilers for economic working should be rated to supply load at the estimated daily average load factor of the house, so it should be able to supply the maximum load for a small number of hours. Under emergency cases the Drum type boilers fail to supply overload without running the risk of damage to furnaces and of incomplete and wasteful combustion though they can meet sudden rushes of demand for short duration with their large water space. While in water tube boiler steam can be raised more rapidly and the boiler can be forced to a high degree of overload. It is unable to meet sudden rushes of demand due to small water space without great variation of pressure. It possesses the advantage over the drum type of the refractory nature of the brick work lining facilitating combustion.

(4) The selection of boilers depends to a great extent upon the floor-space available. Where the power required is small and floor-space limited, vertical multitubular boiler can be safely recommended, though the efficiency of this type of boiler is less than that of the Lancashire.

The space required for Water tube boiler. 2·2sq.ft. /kw.
" " " " Dryback marine type ... 7 sq.ft./kw.
" " " " Lancashire boler ... 3·5 sq. ft. /kw.

In the case of power houses with units of plant exceeding 500 kw. the Dryback and Lancashire type becomes prohibitive on account of space occupied and the increased cost of buildings pipe work and attendance. The water tube boilers occupy only about $\frac{1}{4}$th the space occupied by the Lancashire of the same rating. Hence for large power houses water tube boilers are indispensable.

(5) For export work and in places where the transport of minimum weight is necessary, the water tube boilers are indispensable. They, being of detached sections and no section being too heavy or bulky afford great facilities of transportation where the boiler is required in outlying stations. The station type possesses advantage over the Babcock & Wilcox in that the drums are smaller and hence can be more readily transported to up-country stations; which are often difficult of access.

(6) Durability and simplicity of design. Generally the water tube boilers are safer than the drum types. They are also more immune from the danger of desastrous explosion than other types. The design provides more facilities for inspection, cleaning and renewal of tubes. Accumulations of soot on the exterior of tubes may be removed by a steam house and jet for which access is given by small hand holes built into the side walls of the brick work setting or by scrapers. As a

unit the water tube boiler and setting is more complicated than horizontal return tubular or vertical boilers. While in the drum types, one must go inside the drum to do any of the above things.

The tubes can be easily inspected by taking out the caps and placing a lamp at one end and also can be easily cleaned.

The chances of overheating are much greater in drum types, and the parts are subjected to stresses due to unequal expansion entailing possible rupture. The only disadvantage the water tube boilers possess is that it contains a large number of tubes, the caps of which need to be removed occasionally for inspection and renewal of the tubes are the source of trouble. The Lancashire type possesses reliability and freedom from repairs.

(7) Facility for managemet and labour available. Where the power required is small, hand stoking is resorted to, and skilled labour is required for this purpose. Often for want of skilled labour a wrong class of mechanical stokers is selected leading to inefficiency. Mechanical stoking is always resorted to for large units.

(8) Efficiency and Economy :—A water tube boiler possesses a higher efficiency, for it provides a better circulation of water and less heat radiating surface. It also can be subjected to a higher pressure than the drum types; leading to increased efficiency. The efficiency claimed by the manufacturer is 75 to 80%. While the drum types have an efficiency of about 60%. The

efficiency depends upon the rate of evaporation per sq.ft. of heating surface. This rate has a critical value i.e. the efficiency of any type of boiler will be less if the rate of evaporation be increased beyond or reduced below the critical value. The efficiency may be impaired through not selecting the most suitable type of boiler for the particular class of fuel available.

The initial cost and the cost of setting of the water tube boilers are much greater than the drum type ones. Hence before deciding upon the type of boilers to be adopted it should be thoroughly worked out whether the interest and depreciation on the increased capital outlay incurred in the case of water tube boilers can out-weigh the cost of saving in coal due to increased efficiency and the facilities provided with respect to floor-space and cost of transportation etc.

To sum up, Lancashire boilers can be recommended in stations of moderate sizes where there is space for them and their economiser, as they are easy to manage, require practically no repairs, are easy to manufacture, affording ample competition as to their price, have large water space, and can be banked up without excessive loss of heat. The Babcock & Wilcox boiler can be recommended in cases where floor-space is limited, very high preasures are required and where units are large. Where little floor-space is available the marine boiler is efficient and useful, it has the serious drawback of bad circulation, excessive repair and is not adapted to as high pressures as water tube boilers are.

STANDARD LANCASHIRE BOILERS

Size of Boilers.		Weight of Boilers for following steam pressure.		Weight of Boiler fittings.	Heating surface.	Grate Area.	Chimney height.	Coal consumption per hr.		Total Steam per hour.
Length ft.	Diam ft.	120 lbs. tons.	180 lbs. tons.					Per sq. ft. of Grate Area.	Total.	
22	6.5	11.25	15	3	570	25	100	20	500	4,000
24	7	14	18	3.5	680	29.75	120	24	700	5,600
28	7	15.75	20	3.5	800	32	130	25	800	6,400
30	8	20.25	27	4	1000	38	180	32	1220	9,760
30	8.5	23	30	4.5	1050	40	185	33	1320	10,560

The evaporative capacities are for a good quality of coal of about 13,500 to 14,000 B. Th. U. and assuming the boiler to be fitted with economiser of adequate and properly proportioned heating surface.

Heating surface.	Evaporation per hour (Actual).	Construction.						Furnace.	Approximate weight (Packed).	Space occupied.			Two boilers in battery.
		Tubes.			Drums.					Single Boiler.			
										Over Brickwork.		Height when hand fired.	
		Wide.	High.	Long.	Number.	Diagram.	Long.	Area.		Length.	width.		Width.
Sq.ft.	lbs.							Sq. ft.	tons.	ft. in.	ft. in.	ft. in.	ft. in
119	360	3	4	6	1	24′	10′-5″	5.20	$3\frac{3}{4}$	9-6X	4-5X	10-$5\frac{1}{8}$	8-0
983	3000	6	8	16	1	36	21-1I	19.15	12	21-0X	6-10X	14-1	12-2
1827	5600	9	9	18	1	48	24-3	33.50	$18\frac{3}{4}$	23-0X	8-7X	16-$1\frac{7}{8}$	15-8
3580	11000	16	10	18	2	42	24-1	67.50	$31\frac{1}{4}$	23-0X	12-8X	17-$3\frac{3}{8}$	23-10
8283	25000	27	14	18	3	48	25	168.00	$69\frac{3}{4}$	23-6X	19-1X	22-$5\frac{1}{4}$	—

Appendices to chapter X

(George I Rhodes in Standard Hand book for Electrical Engineers).

A. "**Engine or turbine room operation** offers a less fruitful field for improvement since the inherent economy of the units, more particularly of the turbines, is less under the control of the operators. With engines, however, it is highly important that valve settings be maintained properly. The proper loading of units has some influence on economy. The balance of exhaust steam produced and that needed for feed-water heating is particlarly important at light loads, when ordinarily there is an excess of steam which is wholly wasted. Electric drive of some of the auxiliaries frequently serves as a corrective. Air leakage into the condenser is an important source of loss.

B. **Boiler-room practice** affords probably the most fruitful field for improvement, as it has hitherto been the most neglected. Numerous instruments, meters and devices are on the market which make possible a continual check on the efficiency of the boiler room. It is not only possible to know the overall efficiency, but to determine readily just what are the causes of inefficiency; there are automatic devices, also, which remove some of these causes. A careful study should be made as to the variation in efficiency with peak load and load factor, so that the inherent improvement in economy with good load factor shall not be mistaken for the results of better operation. Determinations

should be made as to the proper number of boilers to use, the relation between active fire hours and banked fire hours, and just when it is profitable to let the fires go out. It is highly important that the boilers themselves be kept clean both inside and out; means are available to facilitate this work, both chemical and mechanical. The firemen should be carefully instructed in proper methods of firing and closely watched to see that they follow instructions."

CHAPTER XI

General Organisation of a Central Power Station.

It is obvious that the success of an undertaking depends upon the management and the management of the scheme depends upon the organisation. Too much care and thought cannot be bestowed on these. Every individual case is governed by its own local and peculiar conditions and no universal rules of organisation can be laid down for all works. A few important guiding principles may be laid down here.

For any big enterprise a company should be formed and the Board of Directors or the Municipal Committee should be the ultimate controlling power and subject to their control the supreme authority must be vested in the engineer. The director's duty is to say WHAT must be done and at what maximum cost. The engineer's duty is to say HOW it is to be done, and if there are financial limitations, to acquaint his directors with ALL possibilities, within their power. It will be seen that a knowledge of pure science and technology will be necessary in almost all problems and hence whether from the theoretical Engineering side or from the side of practical operation or from the purely commercial side the successful Engineer with a sufficient commercial knowledge and aptitude will be the best person to

control the whole scheme. His function will thus be consulting and managerial. He will plan and supervise all new works. He must be thoroughly conversant with the works of every department and the responsible head of each department must be in close and direct touch with him. He should, however, strictly confine his dealings to the heads of the department and on no account go over their head or interfere in any way with their subordinates for whose work they are responsible to him.

We consider that much friction and nepotism will be avoided if all subordinate posts are filled by the directors from a list approved by the chief engineer.

The head of each department must thus work under the chief Engineer who should be well acquainted with the work of each of his immediate subordinates and must often examine fully the details of the work. He must not be a figure-head or a puppet, but must make his influence felt in every department, guiding its work and shaping its policy in all matters.

He should support his staff, see to their prestige and make their authority respected by those under them, while among the various members of his staff he must promote good feeling and loyalty to the undertaking as a whole, securing a healthy spirit of emulation between departments without provoking jealousy and thus harmonise the works of the various departments which must thus work in conformity with one another.

Every employee should have a right to appeal to the chief Engineer and vexatious or malicious complaints should be severely dealt with. But no subordinate should ever be rebuked in the presence of others.

The Chief Engineer should delegate the work somewhat as follows :—

(1) Second Engineer to take control in the absence of the Chief Engineer and to help him at other times in purely Engineering matters.

(2) Private Secretary to the Chief Engineer.

(3) The Chief works' clerk.

(4) The Electrical Engineer.

(5) The Steam Engineer.

(6) The Mechanical Engineer

(7) The Distributing Station Engineer.

(8) The Instaliation Inspector.

(9) The Street Lighting Inspectors

(10) The Head of the Standardising Department.

(11) The Chief Draftsman.

In a small station, groups of these departments would, of course, be controlled by a single person. These various departments though distinct and self-contained are mutually dependent and the work of one department is complementary to that of the other.

Arrangement of the equipment in the Power Station :—(1) There must be ample operating space around every machine and necessary apparatus. (2) The switchboard should be well lighted and so situated that

men may move about it, without interfering with the operations of the other machines. (3) There should be every facility for extension as almost every paying plant is a growing one. The main switchboards should be so fixed that they may not be damaged by water, steam, oil, broken belts or ropes. They must be so placed that they are easy of access for the mains from the generators and from the streets.

Control :— The control of the construction of a plant should be as efficient and thorough as may be practicable. All material supplied, and every operation should be carefully inspected and a systematic record kept. Such a record will be equally useful to the Contractor, the Directors, and the Engineer.

Market Analysis :—First survey the area if necessary and prepare a list of all existing power plants and users in the city, note their condition, output, operating personnel, fuel consumption, the periods and character of Power Service, the rate paid for power and light. From a complete power canvass determine how much of the power business can be secured for the installation under consideration.

To the prospective customers explain the advantages of electric power as compared with mechanical drive, the efficiency of transmission, independence of the machine arrangements from location of shafting, cleanliness and greater possibility of machine speeding. The most important point is to show him the reduction in cost for

the power used by pointing out the fact that he will pay only for as much power as is doing actual work for him and that he will be independent of labour or fuel price, boiler, pumps, engines, breakdown and repairs and that his power charge will be a fixed item while otherwise it is highly problematical, and that electric lighting is immensely superior to all other illuminants.

The feasibility and practicability of a scheme are not entirely established if only the power and the market are available. We have yet to consider the question of Government Control and the State Laws regulating the fuel, land titles etc., and in the case of hydro-electric plants the rights and the practicability of an economic development.

The investment balance, or the summation of the capital outlay and the returns promised by the enterprise, the interest, sinking fund, cost of maintenance, operation, depreciation, taxes and insurances on the one hand and the receipts from sale of product on the other should be carefully considered. The balance assuming the total investment, interest payable during construction period, cost of lands, rights, franchises and legal and engineering services on the one hand and the debits for this balance such as fixed charges, interest, depreciation, administration, taxes, insurance and operating costs should be carefully considered for determining the feasibility and practicability of a scheme. The larger capacity developments will show a greater surplus. If the

investment balance shows a satisfactory profit the success of the scheme is almost a certainty.

Presentation :— The Engineer should sum up the findings from his investigation of the market, power capacity, feasibility, practicability and cost of the factory or installation and submit his report with such documentary proof and legal opinions as the occasion requires. The report should be exhaustive in every detail which is a link in the completed chain. It should contain all arguments, comparative costs and output data and the reasons why the recommended programme will guarantee the most resourceful and remunerative scheme. He should then give a description of the structural plan of the proposed works with brief stability proofs of the essential parts, and a concise specification of specially adapted construction programmes and methods. He should present the detailed estimates supported by quotations of materials of recent date with delivery cost to site. The estimates should be made after the designs are completed and checked and should give details of every structure, their dimensions, weights, quantities etc. and specifications of every class of structural material, proper qualification of labour and labour costs. It should conclude with a summing up of all the different materials required, grouped in accordance with proper classifications as to their character and cost. Add to the total cost the charge for superintendence, inspection, insurance and finally some arbitrary per cent. addition depending upon the thoroughness of the

detailing of items for contingency allowance covering accidents, breaks, washouts, delays etc. The quantities should always be quoted in positive figures if possible.

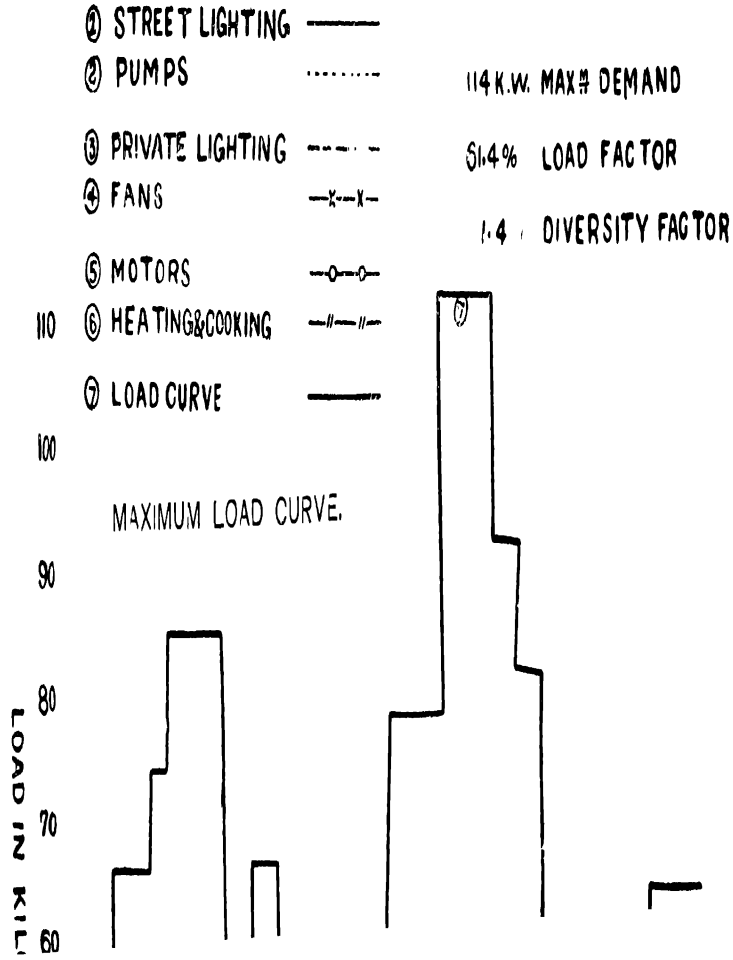
It should close with the investment balance based upon the most remunerative scope which can now be definitely determined and from this the cost of the product per kilowatt-hour for any assumed load factor can be calculated.

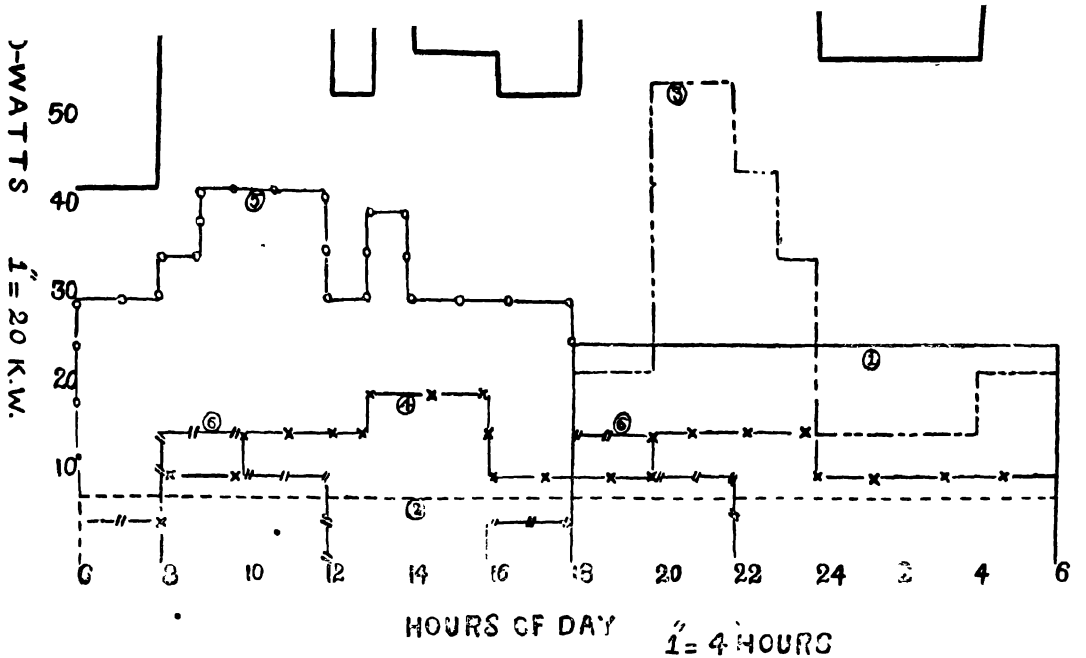
It is not a wise or useful policy to suggest an alternative programme, because only the most feasible project should be advocated : nor should estimates be quoted in lump sums for power house equipments, dam, canal etc. As the lump cost cannot be correctly known to the author of the report without his having developed it step by step through detail items, there is no reason why these should not be given in the report. Enter all calculations in a computation book devoted to that particular project. Every entry should be clear and precise, each separate calculation should be given in a separate page and a comprehensive index for checking the items should be added. All sheets containing plans should be of uniform size, dimensions should be given in figures and identified by dimension lines, the lettering should be clear, location, plan, longitudinal and transverse section of all structural features with important details should be given.

"**Modern tendencies in Power-plant design** point to inexpensive plants of high operating economy. Expense of construction is reduced by simplicity in

design using few large units; reliability is secured by the use of the highest quality of materials and apparatus rather than by duplication, with its attendant complication. Operating economy is secured through better control of combustion, the use of highly efficient apparatus whose efficiency adds relatively little to the cost of the entire plant, and the attendant reduction in labour cost through the simplicity of the plant and the small number of operating units. The development of stokers allowing very high rates of evaporation in the boilers with high economy, has reduced the investment costs in boiler equipment and building and also improved operating economy by reducing the amount of coal consumed in banked fires. There is a strong tendency toward compactness of layout, allowing only sufficient floor space for the dismantling of apparatus during repair. The perfection of the mechanical design of turbo-generators permits the use of skeleton foundations in which the condenser can be placed with great space economy. The electrical switching equipment still has a tendency toward expensive complication, which the writer believes will gradually give way to simplicity and ruggedness, except in the largest plants." (George I. Rhodes in "Standard Hand Book for Electrical Engineers).

Determination of the Capacity of the power plant:—It is extremely important to ascertain the load or capacity of a plant at the outset, as the initial cost of the undertaking depends on the size and duty the plant is called upon to perform. Since all the various


② STREET LIGHTING
② PUMPS
③ PRIVATE LIGHTING
④ FANS
⑤ MOTORS
⑥ HEATING&COOKING
⑦ LOAD CURVE
114 K.W. MAX.m DEMAND
51.4% LOAD FACTOR
1.4 DIVERSITY FACTOR
MAXIMUM LOAD CURVE.
110
100
90
80
70
60
LOAD IN KIL


)-WATTS
1" = 20 K.W.
50
40
30
20
10
0
8
10
12
14
16
18
20
22
24
2
4
6
HOURS OF DAY
1" = 4 HOURS

processes of a manufacture are not carried on, nor all the temples in a city lighted at once we have to find out what is the maximum demand, the diversity factor and the load factor. If the maximum demands at various quarters in a place occur at all times of the day and night, the diversity factor of the power station will be good and the plant required will be small and inexpensive considering its earning capacity. If in addition the demand for power throughout the working hours is fairly constant, the load factor will be good and the plant will be earning a good return on its cost at all times. Hence first determine the maximum demand very carefully.

Suppose that by actual survey and power canvassing we have determined the following demands in the Cantonment of Benares :—

(1) Public Lighting 25 K.w. steady load for an average of 12 hours a night throughout the year from 6 P. M. to 6 A. M.

(2) Pumping 7. 5 K.w. steady load for 24 hours all the year round.

(3) Private Lighting, 80 K.w. of lights installed, maximum demand 55 K w. between 8 and 10 P. M. Maximum load variable.

Details of hour and load as shown in the curve drawn from power canvass for the consumption assumed.

(4) Fans—24 K.w. of fans installed, maximum demand 19 K.w. between 1 P. M. and 4 P. M. A good all day load and

a fair all night load for 6 months in the year.

(5) Motors—57 K.w. installed, maximum load 42. 5 K.w. between 9 A. M. and noon. A good load all day and no night load whatever.

(6) Heating and Cooking—17 K.w. installed, maximum load 14 K.w. Details as shown in the curve obtained from the power canvass.

Construct the "maximum load curve" of each of the various components or parts of manufacturing processes in question putting time as the abscissae and kilowatts as the ordinates. Obtain the total load curve and the ordinates of all curves hour by hour and so get the maximum load of the plant. The average values are of course much lower.

Now note the following :—

(1) The area of each curve to the base line is a measure of the number of units marketed.

(2) The ratio of the area under each curve to the total area of the rectangle in which it is contained is the load factor of that particular curve.

(3) The peak of the aggregate curve shows the number of kilowatts the plant must be capable of giving.

(4) The ratio of the area of the curve to the rectangle gives the load factor of the plant on the particular day for which it is drawn.

Similar curves of power requirement are made for the whole year and the annual consumption and load factor are deduced from them in the same way.

Owing to the diversity factor the maximum demand on the plant which is the summation of the maximum demand of the various components occuring at different times (here 163 K.w.) is much greater than the maximum load on the plant which occurs at the same time (here 114 K.w).

Selection of units is most important in designing a station The amount and form of reserve plant may depend upon it as the reserve may be in the form of additional plant over and above that required to deal with the load of safe over-load in the machines required for normal running. A reserve plant is almost always wanted at short notice owing usually to the sudden breakdown of a great machine. If the running machines have an overload capacity there is the great advantage that such stand-by can be called into operation instantaneously, and the machines having usually a great factor of safety, there is less deterioration and less likelihood of breakdown. If the reserve is an additional plant, it will take some time to start and in an alternating current system, there may be serious delay. The cost of such reserve will be much more than in the form of extra overload capacity in a running machine.

The points that are to be considered for **determining the size of the sets** are :—(1) The total capacity of the initial instalment of plants required, say during the

first 3 years ; very great foresight and scrutiny of the conditions is necessary for this. It should be remembered that it is on the skill of the Engineer in gauging the needs of the public that success will in part depend. (2) The ultimate probable capacity of the station. (3) The percentage overload considered necessary as a reserve. Having determined the total initial capacity of the plant select the number of generator units in the light of the percentage reserve considered necessary, which means that if one machine breaks down the reminder shall not be overloaded beyond the safe limit. Make the initial instalment large enough, all the generators of equal size and absolutely uniform so that the part of the machines may be interchangeable. This is subject to the consideration that to make the plant economical the smallest machine must not be greatly in excess of the minimum load on the station.

The advantage of having such units will be seen from the following considerations :—— Suppose a power plant is required for a Tea Garden or Sugar Mill in which the nature of the load is very variable, light load. at the beginning which rises to a peak value sometime by the middle of the season and again gradually declining to zero when the crop is finished. If one big unit is worked the result is (1) in the time of light load it is worked at a very low efficiency, (2) the depreciation of a big machine is high, (3) there being no reserve, in case of a breakdown, the whole factory will be stopped resulting in great loss to the company.

If however small units with reserve as stated before are installed (1) at light load only a small unit will run with high efficiency, (2) the depreciation cost will be much less, (3) the reliability of the installation is guaranteed and there is no chance of breakdown causing considerable loss to the business.

Further if the machines are made with interchangeable parts there is the further advantage that even if two or more sets are broken, one set may be set aside and the parts substituted so that with the overload capacity of the remaining sets they can always take up the maximum load without any difficulty, as it is never likely that any reliable manufacturers will design machines with particularly weak parts to break every time.

A Jute Mill near Calcutta had two 1500 K.w. sets. During the season one set had a severe break down for some reasons when the other set took up the load, there was no further reserve, the result was that owing to overload that set was also badly damaged and the company had to suffer great loss in consequence in that season.

In the case of a small plant however the full capacity should be laid down at the start and although a single generating set may be sufficient in small stations it is seldom advisable to attempt running without spare plant, and thus two identical sets each capable of running the whole of a small installation may be installed. If the plant is of moderate size three identical sets are recommended. One to work at times of light load, two

to work at times of heavy load and the third as a spare. Sometimes a battery or a small petrol or oil driven generator may be used at light-load hours.

The size of boilers should be as large as possible, but practically speaking, the Lancashire Boiler reaching its limit of size when it is 30 X 8 and pressure of 200 lbs. In Hydro-electric practice the generator units are more generally determined by the hydraulic conditions than by any other factor and as a rule duplicate units of like capacity are selected to meet unforeseen emergencies. The units are of the largest practical output, only they will be within the limits of economical standard designs.

Selection of Experts.

When the Directors have decided to establish a factory or an electric installation there are three methods of engaging responsible experts to carry out the works :—

(1) **A Consulting Engineer** may be appointed to design and superintend the erection of the work, and a resident engineer may be subsequently appointed to take charge of the work and to manage it, while in a running condition. If the consultant has had actual practical experience of designing and erecting similar works before, he knows all about the work that is to be done and provided the consulting Engineer plays the game success is guaranteed. There are however two objections to this method—(a) The Consulting Engineer generally charges a fee which is a percentage on the

capital expended and thus he is likely to increase the amount of initial capital outlay ; and (b) When once the plant is erected, the consulting Engineer's responsibility is practically at an end ; whereas if he had to run the station himself he would be more likely to take care that every detail was pukka.

(2) **A Resident Engineer** may be appointed to prepare the design and subsequently to manage and run the station. The advantage is that the remuneration of the resident engineer being independent of the initial capital outlay, in order to assure the ultimate success of the scheme he will expend as little capital as is consistant with good and efficient working of the plant and thereby avoid unnecessary interest and depreciation on the initial cost.

The answer to the question of appointing a consulting or a resident Engineer depends upon the magnitude of the undertaking. If the scheme is big, a high class engineer of good experience and standing may be engaged at a decent salary for designing and carrying out and subsequently running the whole scheme. For a work of small scale it is best to secure the services of a consulting engineer having extensive experience in designing similar plants before, and a man of more moderate attainments may be engaged for a smaller salary, to carry on the works along the lines laid down by the consulting engineer and to take charge of running and managing the plant thereafter.

(3) **The third method** is to dispense altogether with the Engineers in the first instance and to invite a contractor to design and carry out the entire scheme and to appoint their own Engineers. It is very simple, but nothing could be attended with more disastrous results. It is obvious that the contractor's business is to sell his shares and push his own trade and his scheme will naturally be so designed as to benefit himself most and may only incidentally suit the requirements of the authorities. This method although financially insane is most unfortunately, the almost universal practice with the Municipalities, Zamindars, Rajas and Maharajas of India, and in a different guise is often seen in India when a supplying company is promoted by a manufacturing company, in which case, the supply company is compelled to be furnished with plants by the promoting company. In a certain district in Bengal a well-known Electric Contracting firm was invited to design and carry out an Electric Installation for the Palace of a big landlord. The lighting, fan and power load as demonstrated afterwards, amounted to from 6 to 8 K.w. and the whole installation including the wiring could have been completed in those pre-war days for Rs12000 at most, and the installation could have been run with a daily fuel cost not exceeding Rs5-0-0.

But that would, in the opinion of the contractors, have been a paltry scheme worthy neither of themselves nor of His Highness the Maharaja. Accordingly they installed two STEAM DRIVEN SETS ; one of 87 and the

other of 90 kilowatts capacity, at a total cost of one and a quarter lacs apart from the cost of the transmission system. One or the other of these sets continued to run for the next decade on about one tenth full load and to consume fuel to the value of Rs30-0-0 per day during all that time, at the conclusion of which they were replaced by a 7 kilowatt oil driven set.

We will not spoil the effect of this lovely example of the futility of appointing the wolf guardian of the sheepfold with any comment other than this : that it is only one of many similar ones to be found up and down India.

Further, it is a very common practice with the contractors, if they are asked to design and carry out the work, to supply different types and units of different makers. Sometimes one set has an Oil Engine, but the other set is a steam set ; one a shunt dynamo, and the other a compound dynamo ; one is a single cylinder engine and the other a two-cylinder engine ; and in most cases the reason is that the contractor has not two sets of the same type, and the matter is urgent. The contractor gets the agency from different firms at different times on different rates of commission and it is his business to push on the trade of the firm who offers the highest commission ; and Janaki Ram would not lose an opportunity to earn when he can, he would not let go to others the chance to earn on any account.

Power-Plant Economics and Tariff.

The load to be carried is probably the most important factor to be considered in a power plant design.

Load Fluctuation :— Lighting systems have steady loads except for peaks. Industrial loads are very steady except for certain applications to intermittent work using large units. Railway loads have considerable fluctuations.

The load factor of a machine, Plant or System is the ratio of the average power to the maximum power during a certain period of time. The average power is taken over a day or a year and the maximum is taken over a short interval of the maximum load within the period The duration of the maximum load should be definitely specified, say half an hour per day, or for one month or per annum. The annual load factor of a central station =

$$\frac{\text{Total kilowatt-hours generated per annum}}{\text{Kilowatts of maximum demand} \times 8760} \times 100 \text{ percent.}$$

$$= \frac{\text{Average load during the year}}{\text{Maximum load during the year}} \times 100 \text{ percent.}$$

Under the same conditions, the average cost of generation and transmission per kilowatt-hour, will be lower, the higher the annual load factor.

The same ratio taken for a day gives the **daily load factor or for the period** and the maximum is taken over a short interval of the maximum load within that period. In each case the duration of

the maximum load should be definitely specified. The proper interval depends upon the local conditions and upon the purpose for which the load factor is to be determined.

Example—A circuit carries a maximum load of 200 k.w. and delivers an amount of energy equivalent to a load of 180 k.w. during 3000 hrs. per year; determine the load factor for the year.

Solution.—

The load factor for the year $= (180 \times 3000 \times 200) 1 24 \times 365 = 30.8$ per cent.

(b) **The station load factor** on which the standing charge is based

$$= \frac{\text{Kilowatt-hours generated per day}}{\text{Kilowatts of plants installed} \times 24} \times 100 \text{ per cent.}$$

$$= \frac{\text{Average load}}{\text{Kilowatt installed}} \times 100 \text{ per cent.}$$

Plant load factor

$$\text{(c)} = \frac{\text{Average load}}{\text{Kilowatts of plants in use}} \times 100 \text{ per cent.}$$

The kilowatts are taken at rated full load. This is very nearly equal to the daily load factor.

Influence of load factor on cost of power

From Standard Hand book for Electrical Engineer.

George I Rhodes.

(a) Fixed charges.—It is obvious that this cost varies inversely as the load factor. It is important, however, that the proper factor be used, namely the annual capacity factor of the total equipment installed.

(b) Operating labour.—It is obvious that in small plants, or plants of very few units, a large amount of labour is unaffected by the load on the plant. As the number of units increases, this portion becomes relatively smaller. It is probable that the ratio of full-load labour costs per hour to no-load costs varies from 2 to 1 in plants of a single unit, to 5 to 1 in plants of a large number of units.

(c) The coal.—The coal required to maintain a plant ready for instant service with one unit running at no-load, consists of that required for its no-load steam, that of the auxiliaries and that for banked fires under sufficient boiler capacity to carry the peak load. This total no-load coal ranges from 25 per cent. of full-load coal in a plant of one unit to 8 per cent. in a plant of many units.

(**d**) **Operating repairs** and other expenses are very indefinite and uncertain except over a long period of time, but probably vary in direct proportion to the load,thus being independent of the load factor.

(**e**) **Total production cost** at no-load varies from 30 per cent. of that at full load in plants of a single unit, to 10 per cent. in plants having many units.

(**f**) **Period of load factor.**—Since the no-load costs in a station are determined largely by the peak load expected during the month or week, it is evident that load factors for a shorter period than a year are advisable. Possibly the average daily or weekly load

factor will give the best method of comparing these costs.

The capacity factor is the ratio of the average load to the total full load capacity of the equipment supplying the load.

The demand of an installation or system is the load which is drawn from the source of supply at the receiving terminals averaged over a suitable and specified interval of time.

The demand factor is the ratio of the maximum power demand of any system to the total connected load of the system or of the part of the system under consideration.

Diversity Factor.—In the distribution of electricity the maximum demands of consumers for general lighting and power purposes, are made at different hours of the day and vary from day to day during the week and from month to month during the year for various reasons. The demand for power purposes is greatest when the lighting load is smallest. The result is that the resultant maximum demand at the point of supply is less than it would have been if these maximum demands were coincident. Thus the sum of the maximum demands of individual consumers is greater than that on the distributing mains from which they are supplied. The sum of the maxima on distributing mains is greater than that of the feeder, the sum of the feeder maxima is greater than that of the

substations, and the sum of the substation maxima is greater than the coincident maximum of the generating station.

Diversity factor is the ratio of the sum of the maximum power demands of the subdivisions of any system or part of a system to the maximum demand of the whole system or of the part of the system under consideration, measured at the point of supply.

$$= \frac{\text{Sum of separate maximum demands}}{\text{Maximum demand on the station.}}$$

Example.—The sum of the maxima of a group of feeders supplying a district is 5000 Kw. and the maximum demand upon the substation is 4000 Kw. Find the group diversity factor of these feeders.

Solution.—

$$5000/4000 = 1{\cdot}25.$$

Improvement of Plant Economy :—

To effect an improvement in the economy of an existing power plant aquire an accurate knowledge of all the elements entering into the cost in that particular plant and then gradually eliminate the elements producing inefficiency. These elements are broadly to be found in :—(a) Boiler room practice, giving the greatest scope for improvement, (b) Engine or Turbine room operation, (c) Electrical operation, (d) Labour shifts, (e) Repairs, to be made as soon as their necessity is observed, (f) Economy in supplies—choice of those adopted to the work, giving the lowest total cost for the object accomplished.

The other items of Power Plant Economics such as interests, profit, tax, insurance, depreciation and suitability of different types of Power Plant have been already treated in different parts of this book.

Tariff :—

(i) **Flat Rate.**—In this system a definite flat rate of so much per unit is charged to all consumers,

It is not satisfactory or fair as the charge per unit is made high and sometimes the profitable consumers, subscribing at times of low load, have to pay the losses on the unprofitable consumers.

(ii) **Maximum Demand System.**—Electrical energy is generally sold by meter but this system of sale does not encourage the consumers who use energy at hours of small load or unusual hours. Hence THE MAXIMUM DEMAND SYSTEM by which the consumer is charged A CERTAIN SUM PER KILOWATT OF MAXIMUM DEMAND AND a low charge per unit actually supplied to cover the consumer's share of standing costs and to pay his share of the running costs. It also does not seem to be fair, for all the consumers have not loads of the same diversity factor.

The maximum demand system discriminates to some extent between good and bad customers, i. e. those taking power at times of no load and those taking it at maximum demand, respectively and is much fairer than the flat rate system.

The object of maximum system is to (1) increase the profits of the undertaking, and (2) diminish the price per unit paid by the consumer.

The Maximum Demand System may be subdivided into two parts :—

(a) There is a fixed charge per K. W. of maximum demand. The consumer may use his full load constantly or only occasionally without affecting the amount he must pay. This system is applied in many hydro-Electric installations, notably at Simla. The K. W. of maximum demand are estimated from the number and candle power of lamps installed, meters being despensed with. The defect of this system is that it encourages waste.

(b) This, makes in addition to a charge per K. W. of maximum demand, a charge of so much per kilowatt hour actually consumed. Two meters are required one for maximum rate of supply, and another for total quantity of supply.

Instances are found in Calcutta, Bombay and Madras where power is supplied for industrial purposes. This requires two meters one to register the maximum amount of current in a given time and the other is an ordinary energy meter which registers the total number of B. O. T. units consumed during the same period. The B. O. T. units registered on the energy meter are divided and charged for at two differents rates, the proportions of the total number to be charged at the

high and low rates respectively depending on the reading on the maximum demand indicator.

Example.—An installation is supplied on the maximum demand system at 8 as. and 3 as. At the end of a certain quarter the indicator registers a maximum demand of 3 kw., the reading of the energy meter being 600 B. O. T. units. Find the charge for the quarter, the first 120 hours being taken at the maximum rate.

Solution :—

3 k w. × 120 = 360 units at 8 as. = Rs. 180/-
600 − 360 = 240 units at 2 as. = Rs. 30/-

Total Rs. 210/-

(iii) **The Telephone System** is so called as it resembles the method of charging for Telephone Service. In this system also there is a fixed annual payment based on a certain percentage of the connected lighting load in advance and a small charge per unit actually utilized. Emergency or decoration lighting and wattage installed other than lighting are not connected, and the consumer is in any event made to pay the standing charges on the fraction of generating plant he requires to be placed at his disposal. It is better than maximum demand system in which the customer pays nothing at all if he uses no current although the generating plant has to be kept in readiness to spply him ; while he pays less, for working at times of heavy load, than he ought to do. Note that the standing

charges in a modern station are much higher than the running charges.

Example —Find the total charge per quarter for supply to the installation whose maximum demand is 100 kw. and in which the consumption per quarter is 50,000 kelvins. The fixed rate is Rs. 100/- per annum per kilowatt demanded and the price per kelvin is 2 annas.

Solution :—

The fixed charge per quarter = $100 \times 100/4$ = Rs. 2500 -
Cost of energy = $500,000 \times 2/8$ = Rs. 12,500/-
Total cost = Rs. 15,000/-.

To sum up; it is only the fact that society is individualistic rather than socialistic that prevents the immediate economic truimph of the large national power station. It is quite certain that within the next few decades the gradual exhaustion of fuel resources throughout the world will force this development upon the industrial nations in any case. It is possible by means of high-tension transmission to transmit power electrically over a distance of 300 miles with a loss of not more than 10%. On the other hand to transmit the fuel itself a similar distance from the pit head means at least doubling its cost. If it is consumed in small plants the cost is redoubled. The concentration of power generation in say fifty power stations favourably placed as regards coal mines and hydraulic power would make available for use all over India at least four

times as much power as could be obtained from the same resources used in small plants. Nor is that all. The principle advantage is not the conservation of fuel; it is the conservation of manhood. The great industrial centres of the West are like furnaces drawing and destroying the peasantry. It is not necessary to the industrialisation of India that this process should be repeated here. In our chapter on the choice of a site we have pointed out the necessity under existing conditions of selecting a site near a large centre of population. If, and when, India is covered with a network of high tension power transmission it may yet be possible to avoid this and combine what is good in the existing conditions of the peasantry: namely their attachment to the soil, with as much of industrial development as is perhaps desirable. But this will be a task for the statesman rather than for the individual. It is not a development likely to be encouraged by private enterprise. It may arise as a result of railway electrification.

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CHAPTER XII

Depreciation and valuation

Depreciation is defined by Webster as follows :— "A falling off of value. When applied to money it means a loss of exchange value or purchasing power. Applied to other things it means a lowering of worth." This is a good example of the kind of definition that leaves the sore place sorer than it was at first.

In this chapter we are going to assume that money does not depreciate. We will be concerned only with the loss in money value of things purchaseable with money. We reserve the word depreciation to mean that, and that only. Nearly all the components of a factory are perishable; some sooner, other later. We shall have to consider these components in detail, and indicate as accurately as we can how much of their value vanishes in each year. The vanishing value must of course be added to the operating expenses, and to the costs, as indicated in hereafter. Usually a depreciation fund is initiated and a portion of the income of the business is paid into it each year. Repairs and renewals are paid for from this fund as they become necessary. In a well conducted business the allocation for depreciation is sufficient to maintain the property at its original value or even to increase it.

There is another aspect of the depreciation of plant. When the perishable property is bought or sold in its life period, it is not, as a rule, considered worth its original value, because it has depreciated in the meantime. The valuation of its present worth is therefore its original worth less the accrued depreciation to such a date. Thus in a correct Balance Sheet it is the present value of plants, buildings etc. that appears as an asset, the original value being diminished by the accrued depreciation up-to-date. The two kinds of depreciation usually recognised are physical depreciation and functional depreciation.

Physical Depreciation is the result of age, wear and tear, corrosion and decay. This kind of depreciation is constantly in progress : the rate of its progress depending upon the conditions of service or use, protection from ravaging elements, and the degree of care exercised in making prompt repairs when necessary. This rate, of course, varies greatly with different forms of machinery, apparatus, plant etc.

Functional depreciation is the result of failure to function properly, in consequence of the lack of adaptation to the service demanded. This may be brought about by either INADEQUACY or OBSOLESCENCE.

The Inadequacy may be due to the fact that the demand for service exceeds the capacity of the plant, which necessitates the replacement of the present plant before the physical depreciation has run its full course.

Of course, the plant is still of value to a locality or service sutiable to its capacity. It is an important function of sound engineering to study the probable future demands on a plant and to so choose the capacity of the machines and arrange them, that the enhanced demand in course of time may be met without desturbing the units as we fore-shadowed in the chapter on Sites and Buildings for Factories. Thus, part of the economy in efficient engineering consists in securing if possible the maximum physical life from any piece of plant or apparatus, unless, of course, it appears conclusively that the total annual charges will be actually lessened by deviating to some other plan or policy. It is easy to realise that the maximum physical life is always greater than the economic life. Generally the material assets of a business cease to be profitable assets some considerable time before their physical life comes to an end.

Obsolescence is that kind of functional depreciation which results when the plant or apparatus become obsolete. This may be due to new inventions or radical improvements in the art, causing a set-back of the present methods or machinery in relative efficiency, or to new demands which did not previously exist. The question whether all forms of obsolescence or allowances for their probable occurrence and effect should be included in depreciation is an open question. The advances in a certain art may be relatively infrequent, but if of a fundamental and revolutionary character they imperatively necessitate the discarding of the old plant. The

other sort of obsolescence may be caused by mere improvements of things already old in the art. In the latter case, the main question is of efficiency and of reduction of the cost of production. When comparing a new and improved machine of this class with an old one of obsolete type but not yet worn out in the physical sense, the question whether the new shall immediately supplant the old, is regulated by the consideration whether the saving in total annual charges resulting from the substitution will extinguish the remaining service value of the old machine within a reasonable period or much sooner than the expiration of the probable life period of the new machine. Thus there are certain cases in which obsolescence is not a proper charge against depreciation, but should be amortized through the application of those annual charges which represent the savings in operation secured by discarding obsolete machinery or plant.

It is easily realisable that provision for functional depreciation partakes of the nature of insurance to cover a risk. Such depreciation charges are rather insurance charges in the technical sense. Such provision, therefore, should depend upon the law of probability applied to the statistics of past occurrences with respect to the abandonment of plant or machinery strictly on account of inadequacy and obsolescence. This will give the monetary value of the risk and the annual insurance charge in terms of the percentage of the investment or cost of the plant. This insurance charge should be

added to the annual charge for depreciation of a physical character to give the gross depreciation charge per annum.

Before we proceed to discuss the method of finding the annual contribution towards depreciation reserve we must define terms connected therewith.

Original cost or Investment (I) the total actual outlay or expenditure for the physical plant, installed and in readiness for service ; it is also known as the physical cost.

Scrap value or salvage (S) is the amount realised from the sale of the worn-out or abandoned plant for what it will bring as junk or second-hand materials.

Cost of removal (R) is the cost of labour and other expense incidental to the removal of the worn out or abandoned plant, to make room for the new plant.

Service or wearing value (W) $= I + R - S$.

This is the net depreciable value of the plant. i. e., the amount which is required to replace the discarded plant, provided the labour, material and other costs remain the same.

Realised Depreciation (W) is another name for the Wearing value.

Accrued Depreciation (A) is the total or cumulative depreciation in the plant on any date expressed in monetary terms.

Present Worth (P) is equal to $I - A$.

The life of a plant is the useful life of the plant. It is always expressed in years. In some cases, the estimated life includes allowances for probable inadequacy and obsolescence, and in such it is inevitably less than the physical life of the plant.

It now being admitted that the question of the depreciation of factories and of plant must be regarded as a matter of paramount importance in the determination of the lucrativeness or otherwise of a business, and in the valuation of properties, the point for consideration being the depreciation rate i. e., the ratio of the number of rupees to be set aside each year towards the depreciation reserve (usually expressed as a percentage of some other sum to be dealt with later). There are various methods and practices followed by various concerns. But questions as to the particular practice to be followed in any individual case must, to a large extent, be left to the judgemnt of those most intimately acquainted with the conditions of the business, for as has been pointed out by Prof. Marshall in his Principles of Economics "Almost every trade has its own difficulties and its own customs connected with the task of valuing the capital that has been invested in a business, and of allowing for the depreciation which that capital has undergone from wear and tear, from the influence of the elements, from new inventions, and from changes in the course of trade. These two last causes may temporarily raise the value of some kinds of fixed capital, at the same time that they are lowering

that of others. And people whose minds are cast in different moulds, or whose interests in the matter point in different directions, will often differ widely on the question as to what part of the expenditure required for adapting buildings and plant to changing conditions of trade may be regarded as an investment of new capital, and what ought to be set down as charges incurred to balance depreciation, and treated as expenditure deducted from the current receipts, before determining the net profits or true income earned by the business".

Whatever may be the method for the determination of the rate, there are five main factors, as enumerated by Mr. R. N. Barber, A. C. A., (in a Lecture before the Manchester Chartered Accountants Student's Society), which enter into the determination of any rule for arriving at the deterioration which has taken place.

1st.—The original cost of the object—as defined above or in the case of a transfer of an established business, the estimated value of the object.

2nd.—Its estimated tenure of life, regard being had to its functions and the conditions under which they are fulfilled including therein volume, character and nature of work, the material on which it is employed, and the personal equation or care taken by the attendants or operators.

3rd.—The extent and value of the renovation or restoration received by it from time to time.

4th.—Its value in use or its present earning power, relatively and comparatively, to other instruments of production used for similar purposes.

5th.—Its residual or scrap value as defined above.

He also adds another factor;—"To these five I would frequently add a sixth, obsolescence, unless it is intended to be included in (2) or (4)".

From what has been said it will be seen that considerable discrimination can be used as to the depreciation rates applicable to particular items, if due regard is paid to all the above considerations in each case. From the accounting point of view, however, there is no ready alternative to the use of flat percentage rates, differentiated according to the general character of plant involved.

Buildings and fixed plants may, therefore, be conveniently grouped as follows and flat rates applied to each group:—

1. Buildings (Land does not usually depreciate).
2. Motive power plant.
3. Mechanical Transmission.
4. Electrical Transmission.
5. Pipe Transmission.
6. Transportation plant.
7. Shop fixtures.
8. Special process plant.
9. Machines.

The above plant groupings are arranged in order to minimise any inaccuracy in the introduction of flat rate, arising out of the different condition and behaviour of different plants.

The life-expectancy of different kinds of machinery and plants is given as follows in Floy's "Engineering Valuation of Public Utilities and Factories".

Estimated Life in Years of Plant Units.

Kind of plant.	Estimated Life in years.
Aerial Lines	20
Batteries, Storage.	10-15
Belting.	20
Boilers-fire tube	10
„ water tube	20-25
Buildings, brick	25-50
„ power plant ...	33.3
„ masonry	40-50
„ railroad transportation	33.3
Cables—high tension ...	20
„ —lead covered ...	20-25
Cable feeders overhead ...	33.3-60
„ underground ...	25
Chimney—steel ...	10-14.3
„ —brick ...	33.3
Condensers—steam plant ...	10-25
„ —gas plant ...	30
Cranes	50
Engines—steam high speed ...	15-20

Engines—general ...	10-33.3
„ —gas ...	15
Furniture and fixtures ...	20
Gas services ...	20
Generators, belted ...	10-20
„ direct coupled ...	13.3-25
Machinery—coal and ash handling	10-20
Motors, electric service ...	12.5-20
„ gas „ ...	25-50
„ water „ ...	20-30
Motors	10-20
Pipe—cast iron (small diameter),	20 40
„ — „ (large diameter)	50-75
Pipe—steel	25-50
Poles—iron	20-50
„—steel	50
„—wood	10-15
Pumps	15-25
Rolling stock cars, bodies, open	20-25
„ electric ...	13.3-16.7
Rotary converters ...	20-25
Stockers—fixed point ...	20
„ —moving point ...	5
Switchboard and wiring ...	20-33.3
Transformers ...	15-20
Turbo generators ...	16.7
Turbines, steem ...	20-40
„ water ...	30
Wires—copper ...	20

Wires—guard	...	10-20
„ —telephone (iron)	...	6.5-15
„ — „ copper	...	30
„ —trolley	...	2-3

These life tables are commonly said to give "average lives" but the authors have yet to see accompanying explanations of how these "averages "were determined. Usually such table do not even indicate whether the life is natural or functional or composite. Students should be on their guard therefore in the use of tables like the above, in practice.

The safest procedure will be for the works manager, after a valuation of the works and duly considering the duties and other conditions of work and configuration, of the plant, to furnish an estimate to the directors as to the life expetancy and therefore the depreciation rate for individual items of the plant, and from that basis the flat rate, appropriate to each group as a whole, may be deduced.

When the factory is built on leasehold land, the question of depreciation assumes a different aspect and calls for legal advice as to the sum to be provided over the period of the particular lease in question to counterbalance the expiration of values that legally pass on the determination of the lease, and to meet the cost of delapidations or making good after occupation.

In the case of municipal expenditure, however, in respect of which loans are raised under the sanction of the Local Government Board, the period laid down by

the authority for the repayment of the municipal loans must be observed. Generally these periods are much shorter than the actual life of the plant.

Two methods of computing annual depreciation rates which are invariably expressed in terms of percentage, are generally used.

1. A fixed percentage on original value.
2. A fixed percentage on deminished value.

The Straight Line Method is based on the assumption that depreciation accrues according to a straight line law, in the simple ratio of age to life. The rate (d) is expressed thus

$$d = 100\frac{W}{l \times l} \text{ (percent) where } l \text{ is useful life in years.}$$

It has received the approval of several Public Utility Commissions.

Example 1.—A machine of original cost of Rs. 100/- is considered to have a life of 5 years after which the scrap value will be Rs. 10/-. Then the rate of depreciation will be—

$$\frac{90}{100 \times 5} \times 100 = 18\% \text{ nearly.}$$

Therefore at the end of the 1st year the contribution towards depreciation fund		= Rs. 18/-
at the end of 2nd year	...	= Rs. 18/-
„ „ 3rd „	...	= Rs. 18/-
„ „ 4th „	...	= Rs. 18/-
„ „ 5th „	...	= Rs. 18/-
Then the scrap value	...	= Rs. 10/-
		Rs. 100/-

A fixed percentage on diminished value method consists in writing off every year a fixed percentage of the residual of the preceding year. The rate—

$$d = \left\{1 - \sqrt[L]{\frac{S}{I}}\right\} \times 100 \text{ (per cent).}$$

The reason for the adoption of this method, is that repairs on a plant tend to increase as time goes on until repairs become so great that it is no longer economical to operate the plant. If a fixed proportion is written off every year to cover depreciation it is evident that the charges to overhead expense for depreciation and repairs will increase as times go on. Because of this, the plan of writing of a fixed percentage on diminished value is sometimes used.

Example. 2.—For the same plant the rate of depreciation will be—

$$1 - \frac{10}{100} = 37^{c}$$

Thus at the end of 1st year the annual charge towards depreciation will be—	...	= Rs. 37/-
Reduced value	...	= Rs. 63/-
at the end of 2nd year, depreciation ..		= Rs. 39.5/-
Balance	...	= Rs. 23.5/-
at the end of 3rd year „	...	= Rs. 14.5/-
Balance	...	= Rs. 25-/-
at the end of 4th year „	...	= Rs. 9.25/-
Balance	...	= Rs. 15.75/-

at the end of 5th year " ... = Rs. 5.75/-
Balance or scrap value of the plant = Rs. 10/-

Expert opinion differs as to whether it is necessary to lay aside depreciation reserve for future use. In many manufacturing business the rough-and-ready method is adopted of charging to capital, in addition to the original cost, the cost of all renewals, alterations and extensions of buildings and machinery; and the Profit and Loss A/C is debited in respect of depreciation with a percentage of the total amount in the Ledger under those heads. In some cases, however, proprietors are content to charge their P. and L. A/C with an estimated fixed sum yearly for depreciation, and they include under this term repairs and renewals. The amount so charged they credit to a depreciation fund and debit the a/c with the amount expended in repairs and renewals. In some undertakings, for example, most railways, the deterioration of the plant is taken to be adequately and fairly provided for by the current expenditure upon repairs and renewals which is debited to revenue a/c and no cognisance is taken of the depreciation in the a/c. Such a system may possibly prove unobjectionable when, an undertaking has been in operation for a number of years, and a permanent relation has been established between the initial cost and the cost of repairs required to maintain the plant at full value but this system has nevertheless the risk of a/cs of particular years being very badly balanced. In the case of the water companies of Great Britain,

there is no fund called the depreciation fund but they are allowed by Act of Parliament to place to a reserve fund surplus profits to the extent of one-tenth of the capital, and as renewals are paid for out of profits, it follows that any abnormal charges in respect of deterioration are indirectly met out of this reserve fund. In general it may be said that unless considerable addition and extensions are constantly made, the system of charging all repairs and renewals to revenue, but making no allowance for depreciation, will not in the long run prove satisfactory. Unless proper care is taken, some years will be made to appear more lucrative than others when heavy renewals come up with in adequate funds to meet them. In certain cases only maintenance can therefore be said to balance depreciation. The cases are:— "Where the plant wears out so quickly as to need replacement at short intervals affording constant proof, by the mere continuance of working that not only the earning power of the factory is maintained, but also the capital value, or that of undertakings so large and permanent as to afford a wide average of deterioration and renewal over 'the whole plant". (Matheson— The Depreciation of Factories and their valuation). It is worthy of note that even in the two cases referred to, Matheson speaks with some hesitancy and alludes to such a mode of procedure as a venture.

Where recourse is had to a fund for depreciation reserve, the proper deposition of this reserve pending its use for the purpose originally intended, is a subject

which has received much discussion without evolving any hard and fast rule that meets with general approval. In particular if the property is one which earns more than 6% or so, there will be some advantage in investing the depreciation reserve, or some portion of it, in the extension of the plant. This also possesses the advantage of reducing the requirements for fresh capital in extending the business; indeed in some cases it has become the policy to invest the whole depreciation reserve in this manner. The disadvantage of investing reserves in the business itself is the same as the disadvantage of carrying all ones eggs in one basket. If that basket is dropped..... ...!

VALUATION.

Whether in the ordinary course of his work or as a professional valuer, an engineer is often called upon to estimate the value of a factory or of a plant.

Valuation is the process of ascertaining by examination and survey the present and prospective value of properties or the earning power of any asset.

Such a valuation is required within the works when the confirmation of the book values of the plant becomes necessary for works accounting purposes. With the post war necessity of reviewing capital values in the light of altered currency values, this work becomes increasingly important, in view of its essential bearing on depreciation rates. Valuation of the plants is also necessary for the settlement of price when the property or the plant is undergoing a change of proprietorship.

When any such occasion arises, a professional valuer is called in and only his certificate is likely to be held valid in any financial transactions involving the plant values. But without suggesting any restrictions of the field of professional valuation; in any fully organised works, the works staff ought to be able to determine the value of the plant when it is required for account purposes. The usual difficulty in applying professional valuation in such cases is the lack of detail figures from which departmental figures can be obtained. The professional report will include probably an excellent description of the items included in the valuation, but no values, except as to totals under a few headings. In preparing for a works valuation, the works accounts should be previously organised on lines that will accord with those to be adopted in the inventory, and this will facilitate the adjustment of valuation afterwards, from year to year, with a minimum of further inventory.

The basis for valuation recommended by the authors is the replacement value. The replacement value of any machinery is what new machinery of the same capacity and quality would cost at the time of the valuation. The current inventory value is then obtained by deducting from the replacement value the money equivalent of depreciation according to the age of the plant.

The reason for adopting this replacement value instead of the original cost, is that the effects of currency

inflation, or deflation, and other periodic fluctuations of value are thereby eleminated. The cost data information may be wrong, for the cost of alterations may have been added to the book value of the plant though such alterations were required rather to maintain than to increase the value. Thus the replacement value basis will correct the book-value so far as they may be wrong. There is too, the insistent question of change in currency values making original pre-war costs quite misleading to-day; the book values of the pre-war period being much less than the post-war period valuation. A yet further point is that the use of replacement values gives a common ground of reference in criticising the ultimate inventory values, often required for guidance in ascertaing the value to be covered under fire and other insurance policies. Another disadvantage of the cost data is that the classification adopted for a work's valuation is frequently different from that of the cost A/Cs of a much earlier date. As a rule, a valuation includes value of trangible objects only, labour costs of installation are omitted. They must not, however, be forgotten by the purchaser.

The depreciation rate allowed in the case of these valuations, as recommended by the authors should be a regular percentage deduction, each year of life, from the diminished value of the item. This is no simple job. Much labour will be saved by the use of the table given below:—

Depreciation by percentage on diminished Values.

Table of Remainder Values Expressed as percentage of Basis Value.

Number of years.	Percentage Depreciation per Annum.					
	10%	12½%	15%	20%	25%	30%
1	90.00	87.50	85.00	80.00	75.00	70 00
2	81.00	76.56	72 25	64.00	56.25	49.00
3	72.90	66.99	61.41	51.20	42.19	34.30
4	65.61	58.62	52 20	40.96	31 64	24.01
5	59.05	51.29	44.37	32.77	23.73	16.81
6	53.14	44.88	37.71	26.21	17.80	11.76
6.5	...	...	...	...	...	10.00
7	47.83	39.27	32.06	20.97	13.35	...
8	43.05	34.36	27.25	16.78	10.00	...
9	38.74	30 07	23.16	13.42	...	...
10	34.87	26.31	19.69	10.74	...	...
10.3	...	...	...	10.00	...	...
11	31.38	23.02	16.73	...	...	...
12	28.24	20.14	14.22	...	...	...
13	25.42	17.62	12.09	...	...	...
14	22.88	15.42	10.28	...	...	...
14.2	...	...	10.00	...	...	...
15	20.59	13.49	...	...	...	...
16	18.53	11.81	...	...	...	...
17	16.68	10.33	...	...	...	...
17.3	...	10.00	...	...	...	...
18	15.01	...	...	...	...	...
19	13.51	...	...	...	...	...
20	12.16	...	...	...	...	...
21	10 94	...	...	...	...	...
21.9	10.00	...	...	...	...	...

N. B —The Scrap-value in the above table is taken to be 10 o/o of the Basis value

An illustration of the use of the table is given below:—

Suppose the basis value of an oil engine is Rs. 20,000/-. Its age is 10 years. The rate of depreciation is 15%. Turning to the table it will be seen that its remaineder value after 10 years is 19.69% of the basis value. Thus its present worth is Rs. 3938/-.

The work valuer must have a full technical knowledge of all kinds of property, if he is accurately to determine the appropriate depreciation rate. It will often be found that the rate allowed by the valuer is different from that allowed in financial a/cs. The best practice will be to settle the depreciation rate in consultation with the work manager who is well acquainted with the workings etc. of his own plant.

In the taking of a works inventory the acting works valuer must be very methodical, should possess sufficient technical knowledge and should devote his whole time to it until the work is complete. An up-to-date works plan, containing the location of machinery, pipe service, lighting service systems etc., if available will be of distinct aid to the valuer in his work. The existing plant a/cs, if complete, should influence the holdings selected by the valuer and thus make his report of more use for the works a/cs. The valuation of the land and building form difficult items in the total valuation of factory or plant and it often happens that a land surveyer and an architect, over and above the works valuer are needed.

For these particular items, the knowledge of an engineer may prove inadequate.

It will be of great convenience to the works valuer (in big affairs) to have a short-hand clerk going round with him as he proceeds in the factory taking down the necessary informations for his valuation. For such items as Mechanical Transmission, Pipe Transmission, Electrical Transmission and Shop Fixture—it is convenient in the first instance that the value's clerk should go to the Millwright, Pipe Fitter, Electrician and Joiner (i. e. those people whose business it is to keep the particular plant in order) respectively, and take down from them the requisite information in good order. This can then be easily verified by the valuer himself. The usual practice in estimating the replacement values for the above items is to add a margin to the material cost for the installation and connections. This margin is better taken as so much per foot run graded to different sizes. The valuer should not be less careful in the valuation of these minor details, for they occur so frequently as to account for a considerable value in the bulk.

The best practice will be, in taking the inventory to note down the age of the plant, either from the plant records or from the shop staff, and to comment on the probable life of each item, more particularly in view of the likelihood of early obsolescence or supersession by more modern plant.

The inventory data should be finally entered as shewn :—

	Class of plant.	Plant No.
Maker..... Description.....	Location. Date.....	Dept.....

Date New.	Original Book Value.	Basis Value.	Depreciation Rate.	Age	Investigated Value.	Probable Life

Date. By.

Then valuation of loose plant is largely influenced by the financial position of the concern. By loose plant is meant all attachments and accessories that are not integral part of the machines, but are really extras that theoretically could be used generally, although in practice such items as chucks may only be used on the machines to which they are fitted. In some cases, when the financial position is strong enough, no value whatever is put on the loose plant that has been put into use. In other cases all loose plant is valued *at cost*, the reason being that so long the items are good enough for use they are worth full value. But the most satisfactory and straight-forward method is to value the loose plant on replacement basis and then to take a proportion of this value for inventory purposes. The argument in favour of this is that it gives an idea of the real values. The ready method of stock taking in this case will be by weight, although there may be some items which have not been bought by weight, and for which an average weight basis should be calculated.

The authors recommend, the method laid down hy Mr. Elbourne in "Factory Administration and Cost Accounts" for the groupings of loose plant and the definite proportions to be taken of the replacement value to arrive at the inventory value. The following table is quoted from that work.

Loose Plant Groupings.	Possible inventory Valuation Basis.
1. Belting and Driving Ropes	Replacement value less ... „ „ „ 50%
2. Gauges and Mechanical Appliances Standard	... „ „ „ 50%
3. Hand tool—Engineers.	... „ „ „ 25%
4. Holding Appliances for Cutting Tools.	... „ „ „ 33⅓%
5. Holding Appliances for Work.	... „ „ „ do.
6. Machining Tools.	... „ „ „ do.
7. Ordinary Implements and Utensils	... „ „ „ 50%
8. Portable Mechanical Appliances.	... „ „ „ 33⅓%
9. Portable Shop Accessories.	... „ „ „ do.
10. Special Trade Tools and Accessories.	... „ „ „ 50%
11. Testing Gear.	... „ „ „ 33⅓%
12. Transportation, Lifting and Weighing Apparatus.	... „ „ „ do.

N. B.—Subject to individual valuation of important items.

Consideration should also be given to the physical condition of the plant before any such rate as above is accepted; for a firm is at liberty to write down its loose plant to a breaking up price, which would be considerably less than the suggested formulas given above. The table only serves as an illustration.

It should now be clear that it is possible to produce a very plausible valuation which is either greatly in excess or greatly less than the true value. It is not unusual for a firm, or the directors of a firm to conceal its prosperity from competitors by persistent under-valuation of plant added to from revenue. On the other hand over-valuation is of course, an obvious device of persons trying to float an old established business as a Public Company.

CHAPTER XIII.

Jobbing and Mass Production.

So far we have been considering business principles generally. We have now to proceed on a kind of tour of inspection through the workshop. We have to go into the details of workshop organisation, and it will be necessary therefore not only to know that it is an engineering workshop, but also what kind of an engineering workshop. The distinction we wish to make very clearly at the outset is the distinction between the Jobbing shop and the Mass production shop or factory. We do not mean in making this distinction, to suggest that a workshop must necessarily be wholly one or the other.

But we do most emphatically mean that the methods appropriate for jobbing production are nearly always quite unsuitable for mass production, and vice versa.

A Jobbing shop accepts orders for any single job which its manager thinks likely to prove profitable. A mass production shop concentrates on the manufacture of a single specialty in large quantities. This is the prime distinction from which all the others arise.

The Jobbing Shop.

Is always ready to quote a price for any article within the capacity of its plant. It is therefore

necessary that such prices should be estimated that is to say a cost calculated before the article is produced. It is this prophetic character that principally distinguishes estimating from "costing" which is the determination of the cost of production from actual observation as the work proceeds. The basis of reliable estimating is experience, and costing, being recorded experience, is as necessary to the jobbing shop as it is to the mass production shop. But the latter does not use its costing system as the basis of an exact estimate of the cost of an unprecedented job.

Owing to the various nature of its work, the whole staff of a jobbing shop must be pucca engineers. The manager must be a resourceful man, fertile in expedients, and not afraid to tackle anything merely because he has never done it before; the draftsmen must have a sound knowledge of the scientific bases of engineering and of a wide range of machines, and the workmen must be good, and skilful mechanics who can be trusted to do a fair day's work for a fair day's pay. It will not be found practicable to offer the workmen a contract price depending on the amount of work he does (put him on piece work) because it is impossible where the work is so various to determine in advance what a fair price is. The workmen in addition to being good mechanics must be sufficiently well educated to work from drawings. Without drawing the work of directing men, all on unprecedented jobs, would become impossible. Even with the drawings it will be necessary

to have a good foreman in each department to superintend the work.

The draftsmen should be the kind of men who are interested in any ingenuity, not merely in some particular branch of engineering. They should know just how much is possible in the moulding shop, the machine shop or the smithy and how much is not, and how and in what direction to modify a design in order to make its manufacture easier, and cheaper without sacrificing efficiency. They should be able to imagine themselves in the position of the workmen who will operate the machine after it is made, and also in his who will have to dismantle, and repair it from time to time. They should work always in close consultation with the workshops. They should be familiar figures in all departments of the works exhibiting their half completed drawings to the departmental foremen, and ever ready to welcome suggestions from the man "on the job".

With all they must be essentially brainworkers of the best type: the kind of brainworker that submits his speculations at every stage to the test of experiment.

The workmen must be skilled. The turner should be able to feel half a thousandth of an inch with his callipers. The pattern maker may be almost illiterate, but he must be able to visualize even the most complicated form with all its voids turned into solids, and all its solids into voids; no mean feat of intellectual gymnastics in many cases.

The jobbing shop is now regarded in Western countries as somewhat old fashioned, but the jobbing shop doing a certain amount of new work and many miscellaneous repairs is the best place for a young engineer to get his practical training. He will get a far better training in some jungly place of that type than he would get in some world famous mass production shop such as for instance the celebrated Ford works in America. He will find in the jobbing shop that every one from the mistries upward has something interesting and useful to teach him.

The Mass Production Shop.

The principle which has led to the extraordinary financial success of the mass production shop is quite simple. It is the principle of sub-division and specialisation from top to bottom of the works.

The manager is an energetic business man rather than an engineer. If the specialty is say a motor car, he knows all about cars, not as an engineer knows Carnot's theory, or Bernoulli's Law (probably he never heard of either) but rather as the rider knows his horse; from the outside. He has so soaked himself in car literature and car experience that his intellectual processes have become instinctive rather than intelligent.

Every new machine is first a theory in some engineers brain; then a clumsy experiment in some workshop; then a less clumsy experiment guided by the first, and so on by a process of trial and error to the

perfected machine it remains till a new theory results in the machine that displaces it altogether.

The responsible man at the beginning and end of this process is never the same man. He who designed the first clumsy machine was a thinker. He who designed the perfected article knew every detail of the earlier experiments but he could not have originated them. He is however the ideal mass production manager for that particular machine.

The philosophic reader may find amusement in the fact that the two men described above have, as a rule, very little respect for each other. The first despises the ignorance of the second; the second compares his machine with that produced by the pioneer, and thinks no more evidence of his own immense superiority is required.

The brains of a mass production shop are to be found in the drawing office, but strange to say the said brains know very little of the article being produced except its shape. They are engaged in devising Jigs, Fixtures, Gauges, Templates and other devices for its ever more speedy and economical production. A complete set of these for producing any particular article greatly exceeds in cost and complexity the article itself. An extreme example is to be found in a certain English Motor Car factory where the machine for finishing the cylinder monobloc cost £300,000 contains one hundred and eighty separate electric motors, and turns the casting

out completely finished in four minutes from the time it was put on the machine.

The jigs often exhibit great ingenuity in the overcoming of difficult problems, but the problems are all of the same class. They are all puzzles in spacial relations. The good jig designer has the same relation to the good general designer that the chess player has to the physicist. If he is only a jig expert, he cannot be called an educated man.

As for the mass production workman, it can only be said that he is a coolie, and even that is an insult to the East which has never as yet succeeded in inventing such unintelligent labour as is the lot of the mass production workman. A typical job is boring six holes over and over again in the same part of the same object. He is not allowed nor expected to use any intelligence whatever. The drill is passed through six holes in a jig which prevents him boring them anywhere but in the right places. He never does any other job. So it is throughout the workshop. No workman ever does the work of another, and no workman has any conception of the completed machine to which he contributes his tiny part, any more than the coral insect has any conception of the island he is building.

This workman is in no sense an engineer. Usually he is taken from the street and taught his pitiful trick in a few hours. The only part of the shop where working drawings are to be found is in that part reserved for

the construction of jigs. Even that is sometimes missing, and the jigs are supplied by another firm specializing in their design and manufacture.

In the above paragraph we have thought it right to stress the fact that there is a serious drawback to mass production from the national point of view. These workmen engaged in work no more intelligent than the work of the galley slave usually earn better wages than do the skilled mechanics of the jobbing shop. For reasons which will be better understood later it pays to make that wage, which is invariably a piece work wage proportional to the amount of work done, a substantial one. The result is, a long day of furious physical labour without interest followed by exhaustion which is just as prohibitive of intelectual recreation as it is of physical recreation.

It is tempting to follow up this matter but it would lead us beyond our brief. We leave it, therefore, with the remark that modern civilisation appears to be breeding a proletarian army ignorant and overfed, in many ways resembling the mercenary armies which did so much to overthrow the Roman, and other empires of the past.

As to the deadly efficiency of the mass production methods there can be no doubt. The work turned out is of the highest accuracy, and is as cheap and abundant as it is accurate. How cheap and how good it is in comparison with the jobbing shop articles the reader

may realize by a simple experiment. Let him buy one of these mass produced watches or motor cars, and let him smash some necessary part say the engine or the main spring, and let him entrust the nearest jobbing shop with the manufacture of a new one. He will certainly find that the repair costs as much as the whole machine did originally, and that it never works as well again.

For the next five chapters we will consider jobbing shop organisation only.

CHAPTER XIV.

Inquiries. Progress Cards.

Inquiries Department.

In a large shop this is a separate department with its own head, own filing system, and an outside staff of travellers following up every inquiry as soon as it appears. The ideal is, that on the day the inquiry reaches the office, an urbane gentleman representing the firm should call on the inquirer, full of enticing and helpful suggestions. In that case if the inquiry is genuine, and the traveller knows his business, he ought to come away with the order in his pocket, before the rival firms have had time to prepare and post their estimates. But to cover a whole country with a system of that kind is beyond the means of all but the largest firms.

As most of our readers are students, and as we hope that many of them will start their own business in quite a small way we will assume that the manager attends to all inquiries himself and has no time to get away from his works. It would seem at first sight that he has no chance against the urbane gentleman in the expensive clothes, but that is by no means the case. His great advantage is that he has not got to pay the travelling expenses, the salary, and the hotel bills of the U. G. and can therefore afford to quote a lower price.

It must never be forgotten either by buyer or seller that the former pays for everything in the end. But the small man should also realize that there is not a post to lose if he wants the order.

Benares.
7-4-25.

Your Reference number.....
Our Reference number.....

Gentlemen,

Your valued inquiry of the 5th instant is to hand. Our technical staff is going thoroughly into the matter, and the tender for the lowest price compatible with a sound job will reach you as soon as it can be prepared.

Yours faithfully.

Alternatively if the matter is a very simple one:
"Dear Sir,

Referring to your inquiry for cast iron railings we can supply these to your sketches at Rs. 15/- (Rupees fifteen) per hundred-weight. We could of course quote a lower price but the job would not be such as we would recommend. We do not think you would have any satisfaction in it.

Yours faithfully".

Standard Forms:— These letters are what are called "Standard Forms". The manager should very carefully think out all such letters as above, once for all, and have them copied in a book of Standard forms. he does that, three quarters of his correspondence

reduces to scribbling on the letters he receives "S. F. 7" "S. F. 3" and so on as the case may be, and signing typed letters an hour or two later.

The above letters are designed to make the inquirer hesitate before placing his order with the U. G., at least till he has made further inquiries. They should be posted at once. It is a great folly to postpone writing an acknowledgement till the quotation is ready.

The letter should be filed. It should not be sent into the shop. If it is necessary to consult a departmental foreman, a copy should be sent. Particulars should be entered on a card.

Firm's name and address	(1) Date of Inquiry	(2) Date of acknowledgement
Particulars of Inquiry	(3) Date of Quotation	(4) Date of follow up letter
Reference numbers	(5) Result	(6) Job number
Their's \| Our's		

After (2) is filled up, the card should lie in an open box labelled "Inquiries A" on the managers desk, until (3) can be filled up, when it should be transferred to "Inquiries B". A fortnight later if the quotation has not elicited any response the "follow up" should be sent:—

"Gentlemen,

We trust that our quotation of—— reached you safely. If you will be so good as to state your difficulties in placing the order, we will be pleased to submit alternative proposals.

Yours faithfully,"

If this also fails to produce any answer it probably means that the firm has been the victim of a rival firm anxious to know the tenderer's price and specification for a particular job. In that case "feeler" is entered in space (5) and the card is transferred to "Inquiries C". Any further inquiries from the same source should be ignored. On the other hand if an order results, a job number is assigned to the work, entered in space (6) and a "progress card" is prepared. The letter stating a price which is sent in answer to an inquiry may be headed either "quotation" or "estimate". The former means that the letter is a definite undertaking to supply at the stated price ; the latter that the price is only a guess to which the writer does not bind himself. Generally speaking it is better to quote a price that provides for all reasonable probabilities, and even suffer an occasional loss than it is to offer estimates.

No man in his senses places an order against an estimated price unless he is very well aquainted with the person that offers it.

Progress Cards

Should be of two colours; one red to be used for urgent jobs, very sparingly, and the other white to be used for work in no special hurry It might be supposed that only the urgent jobs would get through the shop at all, but that is not so. It only means that when two jobs are ready to go on the same machine the lal wallah must have the preference. Ample opportunity will arise for the ordinary job at time when that particular machine or that particular workman is not required for the urgent job.

These progress cards should lie on the manager's desk all morning and should be sent into the works towards evening. It should be a standing order that only important movements should be entered on them, as otherwise the departmental foreman will fill them with records of unimportant operations in order to create an impression that they are getting through an immense ammount of work. Here is a progress card after its progress is completed.

Job No.....	Date		Date
Date of Order.....		Patterns complete	
Promised \ Date of		Castings complete	
Estimated / despatch		Forgings complete	
General arrangement Completed		Machining complete	
Detail drawings sent to pattern shop		Erected	
Detail drawings sent to Smithy		Tested	
Detail drawings sent to machine shop		Despatched	

This system helps to keep the manager in his office which as a rule is the best place for him. It is of course essential that all departments should be subject to unexpected visits from the Burra Sahib. But he should never be long absent from the centre of his web.

Appendix to Chapter XIV.

"Factory Administration and Accounts" by E. T. Elbourne contains specimen forms for every conceivable purpose.

"Engineering Economics" by J. C. L. Fish contains a very sensible chapter on estimating.

"A First Course in Commercial Correspondence and Office Routine" by J. K. Grebby contains a number of excellent examples of business letters.

CHAPTER XV.

Workmen's Time Cards. Gate Control.

Workmen's Time Cards

Are intended to ensure that every hour the workman is paid for is charged to some job; not in the ledger, of course, but in the job sheet, which is the central document of the costing system.

There is at present a movement in India, to substitute weekly for monthly payments. We are going to assume that it will be successful, and that all wages will be paid on Saturday. The reader should not have much difficulty in modifying the system for monthly payments, if that should turn out to be necessary.

Unless the workman is leaving for good, he is never paid all that is owing to him up to the date of payment. A part of his wage is retained by the firm, partly to give it time to prepare pay sheets, and partly to ensure that the workman will not leave without due notice. The money paid on Saturday will therefore be all that is due up to Thursday evening. The cards will be collected then, and new ones will be issued on Friday morning. During Friday they should be carefully examined for :—

(a) Cases where excessive time is being spent on one job or one operation.

(b) Cases where the total of hours reported by the workman does not correspond to the total, reported from the gate, by the timekeeper.

The cards should then be sent to the costing department to have the hours spent on each job entered on its job sheet, and then to the accountant for preparation of the pay sheet. All this must be completed before the office closes on Friday no matter how long it takes. The paysheet duly certified by the accountant should be on the manager's desk when he arrives on Saturday morning. After he has satisfied himself that it contains nothing that ought to be investigated, he may write a cheque for the total, and have the money brought from the bank by a trustworthy messenger, who, if he goes on foot should be followed at a short distance by a sturdy fellow capable of protecting him. But it is a false economy not to provide a conveyance for the bank messenger. Every one in the works knows when the pay money comes, and violent robbery of pay messengers is a not infrequent occurrence.

By two O' clock, or whenever it is that the works close, for the week end, the pay of each workman should be ready in a little tin box bearing his number. The manager should occasionally make a raid on these at the last moment and check a box or two at random. Otherwise some clever fellow may try substituting a five rupee note for a ten, and trust that his word will be taken against that of the workman.

The pay of each workman should be handed to him as he passes out, over a high barrier, or better, through a small window as railway tickets are sold. The time-keeper, as the man whose business it is to know every workman by sight, should be present. Arguments about the amount due should not be tolerated at that time. If a workman has any complaint to make, he must reserve it till every one else has been paid. At least five hundred workmen per hour should be paid by this method. As they are paid in their own time there should be enough windows and enough help to complete the whole process within half an hour.

Hours.	Job No.	Remarks.	Workman's No.
			Friday.
			Saturday.
			Monday.
			Tuesday.
			Wednesday.
			Thursday.

Works. Total. Gate.

Foreman's Signature.....

The completed card should bear two identical totals, one on the left obtained by adding the times

reported for different jobs ; the other on the right added in the office after the card has been surrendered, by abstraction from the gatekeepre's report for the week. The back of the card may be similarly ruled in red and reserved for overtime.

Gate control.

If the time fixed for beginning work in the morning is seven O' clock, all the workmen will present themselves at the gates, between five minutes to seven and seven, and the hundred or so who arrive breathless in the last minute will consider themselves greatly injured if every one is not marked present at the hour. It is also quite fatal to credit a man with being in time if he arrives a second after the whistle stops blowing.

The humane and reasonable employer will order his whistle to begin sounding at the hour and to go on for say two minutes but no further concession can be given without starting on a slippery slope that will find every one coming half an hour late after a very few weeks.

The usual system, by which the arrival of several hundred workmen within five minutes is registered, is the brass check system. As the workmen pass the timekeeper (usually at the same place where they are paid on Saturday) a numbered check about the size of a rupee is handed to each of them by the timekeeper. This they drop through a small slot a few steps further on. The brass checks hang in order on a board

immediately behind the timekeeper, but inaccessible to the workmen. As soon as the whistle stops blowing, the time-keeper, by means of the checks, makes a written record of all who have been in time. No one has to be recorded as two or three minutes late, because any one appearing late receives no pay for that half day.

Occasionally a workman, for sickness or some other reason leaves before the end of the day, but the record of this presents no difficulty. Neither does the general departure at the end of the day, nor the coming and going of the few overtime workers. The timekeeper must be at the gate all day. It is a job for a pensioner too old for hard work but still trust-worthy.

The clerks, drawing office staff, and foremen enjoy the doubtful privilege of being free from the attention of the time keeper. They are not fined for being late, but neither are they paid for overtime.

This class of employee should be paid monthly by crossed cheque, and not in currency. It should be a condition of their employment that they maintain a current account in the same bank as the firm.

CHAPTER XVI

Depreciation. The Theory of Overtime. Machine Cards.

We will presently resume our organising trip through the works but before doing so it is necessary to turn aside for a few pages in order to establish one or two principles of fundamental importance, without a knowledge of which, our methods could not be appreciated.

Depreciation.

This means, of course, the loss of value of plant and machinery through the lapse of time. It should be considered as made up of two parts:

(a) Depreciation due to wear and tear caused by use. (b) Depreciation of obsolescence.

It is the latter that is most often overlooked. In the old song it was said;—

"The minstrell boy to the war has gone.
In the foremost ranks you'll find him.
With his father's sword girt to his side,
And his wild harp slung behind him."

Note the curious "internal" rhyme. But that is not the point. The point is, that if the minstrell boy ventured into the ranks of modern war, armed with nothing better than his father's sword, he would have no chance of ever becoming a minstrell man. His

father's sword might be quite intact, and made of a steel the like of which is not produced in these degenerate days, but all that would avail him nothing. The days of the sword are over. Obsolescence depreciation had reduced its value to zero.

It took a hundred generations to make the sword obsolete, but it is our destiny to be born in an age of rapid material progress, which for the last century has become faster and faster. There is unhappily no sign of a corresponding spiritual renaissance, but that is another story. It may be said that quite half the machines being made to-day will never be worn out. It is not true that our ancestors knew the secret of better steel than we can produce. As far as wear and tear are concerned, modern materials surpass those of previous ages. But long before a machine is worn out there is a far more efficient one on the market. This is a fact very difficult to bring home to the young reader. The middle aged person, when his attention is directed to the machines of his youth realises the truth at once. He quite understands that it is not only because it is worn out that he would attach no value to the bicycle his father was so proud of when that ridiculous machine was the last word of fashion.

A very small invention occasionally reduces the value of a whole workshop full of machinary by fifty per cent. Such an invention was the so called "High Speed Steel" which grew to a remarkable efficiency

between 1900 and 1910. In order to take full advantage of it, all machine tools ; lathes, planers, drills, shapers, and millers had to be made with wider pulleys, to take a broader belt, and with stronger stiffer parts throughout. A workshop full of such machinery made before 1900 though quite unworn would hardly be worth its scrap price to-day. The engineer who embarked in business with it hoping to compete with up-to-date firms would be in the same position as the minstrell boy. There would be no chance of success.

The time it takes to reduce the value of any appliance to nothing, in this way, varies of course, with the appliance. Certain forms of material wealth, even appreciate in value with time. Whatever the period may be the engineer who understands his business allows for the loss and computes the added cost as follows :—

He divides one hundred by the number of years he thinks will elapse before the machine is hopelessly old fashioned. This quotient is 'n'. He then assumes that whether his machines are running or not they are costing him (on this account) n per cent of their prime cost per annum. For example :—

If a motor car costs originally Rs 12000-0-0, it is quite safe to say that it will be quite out of date in ten years, even if not used and worn out in five, as it would be if used continually. If it is only hired out say once

a month for a day the cost to its owner of that day will be ;—

Petrol	Rs 20–0–0
Driver's wage	Rs 5–0–0
Obsolescence	Rs 100–0–0
Total	Rs 125–0–0

It would be quite wrong in this case to add an allowance for wear. The car will be as good as new when the ten years have expired : but no one will want to hire it then. He will prefer, probably, to travel by aeroplane. It will be as good as new, but worthless as an agent of competition. On the other hand ;—

Suppose the owner hires it out every day. In that case he may neglect obsolescence depreciation altogether as the car will be quite worn out before it is noticeably old fashioned. The cost to the owner each day is now; —

Petrol	Rs 20–0–0
Driver's wage	Rs 5–0–0
Depreciation due to wear at 300 days per year	Rs 8–0–0
Total	Rs 33–0–0

These are extreme cases of course. An actual one would be intermediate between them. Some allowance would have to be made for both forms of depreciation not forgetting that each tends to cancel the other. If a

machine is seldom used, wear and tear is very small, but obsolescence proceeds at its full value year by year. If it is used continuously wear and tear is in proportion to the amount of use, but obsolescence may never develop enough to be taken into consideration. We have been waiting for the reader to ask us what asset of an engineering business it is that has a negative depreciation. Of course he has n't a ghost of an idea. It is the site, provided it is well chosen.

The simple minded reader has probably also failed to notice that in computing the daily cost of the car in the above examples we have omitted one of the largest items. We thought he would. When the car is done for at the end of five or ten years, it will be not only the cost of the petrol, plus the chaffeur's wages, plus the Rupees twelve thousand which the car cost originally, that will be missing from the cash box of its owner. There will also be missing the five per cent on Rs 12000 for five or ten years which might have been obtained quite safely but for this ill advised adventure in cars. The complete statement in the first case should have been ;—

	Cost of Car per day
Petrol	Rs 20–0–0
Driver's wages	Rs 5–0–0
Depreciation	Rs 100–0–0
Interest on prime cost	Rs 50–0–0
Total	Rs 175–0–0

and in the second case;—

	Cost of car per day
Petrol	Rs 20-0-0
Wages	Rs 5-0-0
Depreciation	Rs 8-0-0
Interest	Rs 2-0-0
Total	Rs 35-0-0

It is very important that the reader should digest, and thoroughly understand these two statements. One of them embodies an essential element of success in engineering enterprise, and the other explains many failures. The items of cost fall into two classes; those which continue whether the car is used or not, and those which don't. Interest on prime cost, together with obsolescence are night and day charges. The manager who, in addition to this ordinary day shift, runs a night shift as well, escapes them altogether in his night factory. The increase of wages which he must pay for night work is always much less than he gains.

On the other hand, any machine or any factory standing idle, is like an open vein from which the financial life of the business ebbs away; slowly perhaps, but without pause, night or day.

Machine Cards

Just as every workman has a card on which his work is recorded; so every important machine should have its own card.

Hours	Job No–	Large Planer	Rate
			Friday
			Saturday
			Monday
			Tuesday
			Wednesday
			Thursday
Foreman's Signature—			

It should be handed in together with the workmen's cards on Thursday evening whether there are any entries or not. The "rate" (hourly cost of the machine) should be computed as follows :—

The cost of power is annas six per horse power hour. (It may be much less, but this is a not unusual cost in India). Depreciation and interest on prime cost may be roughly averaged out as being together equal to fifteen per cent per annum. The rate is thus given by;—

$$\text{Rs} = \frac{6 \text{ Power}}{16} + \frac{15 \text{ Prime Cost}}{100 \text{ Hours worked per year}}$$

If the machine cost Rupees thirty thousand; requires ten horse power to drive it, and runs continuously

for forty-eight hours on each of fifty weeks per year the rate is Rupees five, annas ten.

But this is too good to be true. Such a large machine is more likely to run for five than for fifty weeks per year. In that case the rate is Rupees twenty-two, annas eight.

The installation of such a machine to run only five weeks a year would probably be a mistake. It would be extremely difficult, if not impossible to recover the cost of using it from the customer for whose benifit it was used. It would almost certainly be run at a loss. There is no mistake in our calculations, (there never is) but it would be useless to explain them to the customer. He will be sure to regard Rupees one hundred and eighty for one day's use of the machine as an outrage, and refuse to pay it.

Another man who would have no hasitation in characterising even Rupees five, annas ten per hour as a swindle is the workman who manipulates the machine for a wage of annas four per hour. "Here" he would say, "Here am I sweating all day at this work, and that idle fellow who sits all day in his office with his hands in his pockets, actually has the nerve to ask twenty times as much as he gives me. Why! I haven't even seen him this week!"

In this case, also, explanations would be futile. A great deal of unnecessary unpleasantness will be saved

by either printing the rate on the card in some simple cypher or by omitting it altogether.

Just as there are a number of coolies about the shop whose wages cannot be conveniently charged to any job except by the method of "Overhead Charges" to be explained later, so there are a number of small coolie machines for which it is not practicable to use cards. The grindstone, for instance, is a coolie mechine. But every important machine, like every skilled workman should have its own card.

CHAPTER XVII

Stores. Tool Room. Raw Materials.

The store, where odments such as bolts, nuts, jointing material, and a thousand and one other small articles are kept, is very often the most mismanaged department of the works. Because no great ability seems to be required in a store-keeper, he is very frequently regarded as subject to the orders of the heads of other departments. and under devided authority his affairs become hopelessly confused.

The remedy is to give him autocratic power within his own domain The store should be a separate enclosure, barred absolutely against every one else in the works, except the Manager. The foremen of other departments should be specifically forbidden to enter the store on any pretext whatever. It is usually they who do the mischief.

Small articles should be handed out over a counter. Where heavy articles have to be brought in or taken out it must be done by coolies under the orders of the store-keeper, and not for that job under anyone else's orders. It must be clearly understood by everyone that his is the sole authority, and the sole responsibility inside the store. If this done, the only qualities required of a storekeeper are honesty, and regularity. We do not mean to imply that these are qualities to be despised,

or that they are unworthy of a decent remuneration, but only that no remarkable ability is required.

Nothing should be issued from the store, except in return for a store requisition properly filled up by a responsible person whom the storekeeper knows to have authority to make such requisitions. It must be on the standard form numbered and lettered, so that the person making the requsition can be traced after any lapse of time.

Store Requisition No. E7	Store Requisition No. E7
Date.....	Date.....
Job No.....	Job No.....
Foreman's Initials.	Foreman's Signatute.

These requisitions are the store-keepers "vouchers". He must carefully keep them till his books have been

audited for the year, and he must be able to justify every issue by producing the corresponding voucher.

The Store-keeper's Books:—

The store-keeper should not be expected to keep books in the ordinary sense. On no account should he be allowed to keep a self-contained system independent of the general system in the office. It will only be a muddle, always in arrears, and a source of perpetual annoyance.

The Store's Day Book:—

Is a journal in which is recorded, immediately they occur, every issue and every receipt of goods.

ISSUES.

Date.	Goods	Quantity	Requisition Number	Job Number

The receipts should be similarly recorded in a separate volume of the day book.

RECEIPTS.

Date.	Goods.	Quantity	Invoice Number	From whom received

Rupees, annas and pies should have no place in the store-keeper's books nor in his dealings.

The Stores Journal — is a fair copy of the day book. It is a standing order, that it must be completed for the day before the Store-keeper's day's work is finished If he has no time to do it before the works close for the day, he must stay late and do it.

The store's day-book must never leave the store. It must always be available for the Store-keeper to enter his issues and receipts as they occur. The journal, which is a kind of messenger between the store and the office, must be in the former department all afternoon, and in the latter all morning. No excuse is to be accepted from either for keeping it beyond the alloted time, nor for failing to transcribe the information to or from it.

The Stock Book.— is a rearrangement in ledger form of the stores journal. The accounts are like ledger accounts, but under headings descriptive of articles instead of firms. Here is the stock book open at the folio for polished hexagonal nuts for bolts screwed to Whitworth Standard thread five-eighths of an inch in diameter :—

78 78

Nuts 5—8 Whit. Bright Hex.

Minimum Stock One gross.

Receipts.			Stock.	Issues.		
Date.	Number weight or quantity.	Page. in Day book.		Date	Number, weight or quantity.	Page in Day book.

This book like the journal must be posted every day. The Store-keeper or his Clerk should sit down to it towards the evening when the stores are usually slack, with the journal on one hand, the stock-book on the other, and the day-book in the middle. In the first column on the right hand page should be entered every day, his balance which should correspond to the quantity of the article in stock.

It is usual in many workshops to have an annual stock taking. Everything is taken out of its box or other receptacle, counted, and the result compared with the records. The store cannot be closed for this purpose without serious inconvenience to the works. Accordingly

it is kept open and as many new mistakes are made during that time as during all the rest of the year.

Stock-taking should be continuous throughout the year as described above. The manager, when he has nothing particular to do, (as we have suggested already, that should be his usual condition) should descend on the store once or twice a month without warning, and check over one or two items. If he should happen to open the stock book at the page described above, he should have the box turned out, and the stock of nuts counted in his presence. He should also compare the stock-book and the day-book for that particular item for a month past.

If the correspondence is not exact he should get a new store-keeper. No impossibilities are required from that official. The little that is required should be exactly performed.

Visible Stock.

All stocks should be either on open shelves well lighted from behind, or in glass fronted almirahs so that they can be plainly seen. Glass is expensive, but expanded metal is cheap, strong and durable. It should be used extensively in making the furniture of the store. The roll top desk, and the closed wooden cupboard are always hives of disorder.

The Tool Room.

In small jobbing shops the tool room and the store are usually combined. In that case there is not much

to be said of the tool room that was not said of the store. The function of the tool room under these circumstances is the safe custody of tools used only occasionally. In certain cases, such as files, the tools are issued as consumable stores, and are not returned to the store. The foreman in requisitioning a new file should write on his order "no return". If that is not done the Store-keeper should not issue the new file except in return for the old one which can be recut. The foreman should not requisition a new file except for a big job. Outsize spanners, taps, stocks, and dies, and the like are usually lent by the Store-keeper to the workman who requires them. He may record the issue in a tool book, or the workmen may be given a few brass tokens stamped with their numbers which can be deposited as pledges for the tools they borrow. As soon as it becomes financially possible the tool room should be separated, and combined with a tool and gaugemaking workshop.

Castings and Forgings.

It is probably best to have a material charge of so much per hundredweight, including for the former, the cost of patterns. The cost of a complex casting is much greater per hundredweight than the cost of a simple one is, but the workmen's time cards will look after this difference. The weights of forgings and castings on any job may be reported directly to the costing department by the foremen. A periodic comparison of

the total weight of castings with the total weight of pig iron, scrap, and wood used in the pattern shop, should be sufficient to prevent undue waste. It is not practicable to take these heavy and bulky articles through the store.

CHAPTER XVIII.

Overhead Charges. Cost Summary. Selling Price.

Overhead charges are all those expenses of running a shop which cannot reasonably be charged to any particular job. They include:—

(a) Rent, or interest on capital cost of site, buildings, and machinery; cost of repairs, and depreciation. (Excluding the allowances already made on the machine cards).

(b) Salaries of managing staff, clerical staff, and drawing office staff. Wages of general labourers (coolies).

(c) Cost of power, light, water, and insurance.

The list is not given as exhaustive, but to indicate the nature of an overhead charge.

Having partly calculated, and partly estimated the overhead charge for any period (say a year), our problem is to divide it fairly, and record a share of it as an addition to the cost of every job done during that period. We may as well admit at once that no very satisfactory system of doing this has been invented so far. We will notice and comment on two plans.

A fixed percentage may be added to the costs already noticed. That is to say the overhead cost of any job is assumed to be the same percentage of other costs of that job, as overhead charges for a whole year are of all other costs for a whole year.

The alternative plan is to calculate 'q' which is the annual overhead total divided by the total number of workman hours per annum. The overhead charge on any particular job is then made equal to the product of 'q' and the number of workman hours on that job.

Both these plans achieve what of course any reasonable plan must do, the charging of all overhead costs to the firm's customers, but both can be shown to be ridiculous in certain extreme cases. On the whole, we condemn the first plan reasonable though it may seem at first sight. If the reader will consider again the short list of overhead charges given above he will percieve that most of them are functions of time. They would not be greatly changed if every job was made of gold, brass, or even of wood. It is not often that an engineer has to work in gold, but there are great differences in the costs of his materials, and also in the time taken to work them up. Now, if we assume the overhead cost to be a function of time only, which if not exactly true is nearly so, then we must also conclude that the overhead charge on any job should be proportional to the time spent on it, and not at all to the cost of its materials. This is the second plan, which is accordingly recommended.

The quantity 'q' must be carefully worked out in each case, but for the sake of the example immediately following we will assume that the total annual overhead costs divided by the total number of hours worked for a whole year by all the workmen comes to the same as

the wage earned by the average workman in one hour; that is to say we will assume that 'q' is four annas. It is quite usual to assume an average workman and his wage for the purpose of calculating costs which remains the same for years regardless of temporary market fluctuations.

Cost Sheet.

Job No..... Completed.....Date		Pump. Duplex 4" diameter 6" stroke 1000 gallons per hour
Workman hours	400	Rs. 100-0-0
Castings (Iron)	3 Cwt.	Rs. 36-0-0
Castings (Brass)	5 lbs.	Rs. 5-0-0
Forgings	0·5 Cwt.	Rs. 12-0-0
Jointings and Packings	...	Rs. 10-0-0
Bolts, nuts, and washers	...	Rs. 20-0-0
Planer	5 hours	Rs. 15-0-0
Lathe	8 hours	Rs. 24-0-0
Packing for despatch	...	Rs. 15-0-0
Overhead charge	400 hours	Rs. 100-0-0
Total exclusive of freight		Rs. 337-0-0

Few details are given, as we wish to illustrate a principle, rather than to give a typical cost sheet which might obscure it in a multiplicity of items. Every job passing through the shop should leave such a record behind it. Until many such exist, accurate estimates will be impossible. With them the task of estimating will be increasingly simple as time goes on.

Selling Price.

We come now to a very difficult passage. It is our duty as teachers to give a clear lead to our students, and unhappily, in this crisis, whatever lead we do give is bound to scandalize a large body of respectable opinion. We will not shirk on duty in the end, but we will first hear what the opposition has to say. It will please them to be allowed in the body of the text for once instead of being kept in the appendix, and it will do no harm as we will take care to expose their fallacies before we dismiss them.

(A) "You have very carefully taken account of everything this pump has cost you. You have included a fair recompense in wages for everyone that has helped to make it. You have allowed a fair interest to the capitalist who provided the money for your site, buildings and machinery. By your allowance for depreciation you have even taken care that the capital itself shall not diminish. All these charges together, come to Rupees Three hundred and thirty seven. If you take a pie more than that you are a thief. The fact that

the market price of exactly similar pumps is Rupees one thousand is irrelevant. Unearned money is stolen money."

It is impossible not to respect our friend A. He may not be a business man or a man of the world, but he has a clear idea of the difference between right and wrong and he asserts it like a man.

(B) "If the authors know anything about economics they would recognize the difference between Rupees three hundred and thirty seven and the market price of Rupees one thousand for what it is. It is "Economic Rent" which is the difference between the lowest cost at which men can produce and live, under the circumstances most favourable to low cost, and the market price which was determined as they themselves described quite correctly (for once) in Chapter one. Economic rent is a natural gift like life itself. A is quite right in saying it is unearned but that is no reason why one should refuse it. If A was the logical person he evidently thinks he is, he should refuse to live. What did he do to earn his life? You should accept your economic rent of Rupees six hundred and sixty three in this case, and be thankful just as you accept and enjoy the sun and the air."

A clever fellow this, and we should think, a pukka economist. You can always recognize them by their habit of assuming for their speculations, the validity of natural law. We shouldn't wonder if this man 'B'

could do things with curves, and even with the calculus, that would surprise you.

(C) It's all very well trying to dispose of economic rent with a laborious alleged witticism, but it is a reality for all that. That Rupees six hundred and sixty three appears as a mere accident of trade. If you sell your pump for Rupees three hundred and thirty seven you are allowing your customer to get away with it, and he has no more right to it than you have. The right course is to sell your pump for a thousand and give the surplus to the state. It is a result of the way in which the state is organized, and the state has the best claim to it. If every one did that, all other taxes would be unnecessary and no one's legitimate earnings would be taken from him as they are at present"

A great deal more easily said than done Mr. 'C'. Besides ; we very much doubt if the state would make a better use of the money than we would ourselves. After all ; what is the modern democratic state ? Only a lot of politicians who have gained for a moment the fickle favour of the ignorant multitude.

(D) "Away with all these theories. The only practicable plan is for everyone in the world to sieze what he can, and let the weaklings perish. By this means it is ordained that the world shall progress. It always has been so and it always will be so. It is a law of nature and cannot be evaded.

Because each of these gentlemen has a following in the world we have thought it fair to give expression to their opinions as impartially and fully as we could in a single paragraph. Our own are the following ;—

The managing director of an engineering business, and indeed of any business should regard himself as the captain of passenger ship. 'D' would make him the captain of a pirate ship. The prime concern of the Captain is the safety and comfort of the passengers (shareholders), and of the crew (workmen). We consider, that in his capacity of captain, he would be false to his trust in following blindly the principles of any of the four men whom we have unfortunately allowed to spoil the free flow of this chapter. He has to bring his ship, passengers, and crew safely home, and had better not make any original experiments with them.

If he can get a thousand rupees for an article which only costs him three or four hundred to make, he should take it. That state of affairs never lasts very long. He will need it all when the day comes, as it always does sooner or later, when no one wants pumps at any price. In these days of prosperity he should be carefully gathering a reserve for the days of adversity. He should ignore the clamour of the shareholders for excessive dividends, and see that his plant is brought up-to-date, and extended where ever it can be profitably extended. He should insist that his subordinates are properly paid. Then when the storm comes he will face it with a sound ship and a loyal crew.

It may be true—it is true—that the ship really belongs to the shareholders, but every good engineer will agree that shareholders should not be pampered. He will say that the first claim on the proceeds of industrial work is the claim of the industry itself, and that the shareholders are entitled to the balance, if any. It is for him, not the passengers to say what can be spared with safety. They will thank him, when on his retirement he hands over to them a ship worth perhaps twice as much as it was when he assumed command.

The captain of the ship should not we think be allowed in times of crises to throw any of his crew overboard until it is absolutely necessary. We consider it justifiable to undersell the market right down to absolute cost price if by so doing he can avoid discharging workmen. Such a course has the incidental advantage of keeping 'q' lower than it would be if the shops were half empty. The reader has of course forgotten what 'q' is. He should now read the important parts of this chapter (the parts we wrote ourselves), and more carefully note how it was estimated.

Appendix to Chapter XVIII.

"It is important that the student should carefully avoid the error of believing that the prices and values are controlled by what things have cost to produce in the past. It is the cost which is expected to continue in the future, rather than which has been experienced in

the past, that determines the price at which the market will be supplied"—

From "Elementary Principles of Economics" by Professor Irving Fisher.

CHAPTER XIX

Trade Cycle, and Economics of Mass Production.

Before proceeding to a more careful consideration of the problems of mass production it is desirable that the reader should apprehend the phenomena of the Trade Cycle. It has been observed during the last century or so, that industrial prosperity though on the whole a rising tide has been subject to more or less regular resting periods. They are times of acute depression, and anxiety for business men, and of bitter poverty and hardship for the employed class. Alternating with the trade depression is the trade "boom" during which credit expands, prices rise, everyone is in employment at a good wage, and it seems almost impossible to pay so much for anything, that it will not presently be possible to sell it for a still higher price.

The period between two trade booms or between two trade depressions varies from three to ten years. It is usually about six or seven. No conclusive explanation has ever been advanced. By some economists, and those not the least eminent, the trade cycle is regarded as a natural phenomenon quite beyond the control of mankind. They say that the immediate cause is the success or failure of the world's crops, and the prime cause, a fluctuation in the amount of heat

coming from the sun. But this theory would lead to the conclusion that a great deal of human misery is the act of God and not due to human ignorance and folly. No matter how well attested they appear to be, such theories must not be accepted as they lead to paralysis of endeavour. The classic example is that acclaimed by Yudhisthira at the mystic lake. Though all the evidence shows man that all his efforts are vain and that his life must end in an irretrievable disaster he always has refused and always will refuse to believe it. We ourselves regard trade booms and trade depressions as essentially failures to control credit. We do not think that the problem of controlling it will defeat mankind for ever, no matter what may be the initiating cause of its variations. It is the bright side of mass production, as contrasted with the dark one which we have already noticed that it may be made a powerful agent of credit control.

The jobbing shop lives from hand to mouth. It is the obedient humble follower of the trade cycle. During the slow ascent from a depression it gathers more and more confidence. It employs more and more men, and being as its directors think, certain of orders in the future, buys more raw material on longer, and longer credit. Its employees being, as working men nearly always are, quite improvident, spend their wages as fast as they get them. Even if they were not improvident, they would as poor men have to spend most of them to live. This accelerated spending is

an increase in the velocity of circulation, which is the equivalent of inflation, and tends therefore to raise prices and intensify the boom.

This ascent is the slow part of the trade cycle. Whatever it may be that starts it, (possibly it is a pure accident, such as the failure of a large bank, dishonestly conducted, or the outbreak of war) the whole descent into the depths of depression commonly only lasts a month or so. We have said that the manager of the jobbing shop, confronted with a trade depression, should rather cut prices to the bone than discharge good workmen. Unhappily he will have to cut prices first, and discharge workmen sooner or later anyhow, and the collective result of all shops doing this will be to hurl the whole community into the depths. To cut prices where the medium of exchange has become three-fourths credit, is to deflate, and only makes things worse. Nevertheless the Jobbing Shop must do it. It must realize even at a loss where half or all its liabilities are bills due for payment in one or two months. These are the times when it seems impossible to pay so little for anything that it will not have to be sold at a still lower price.

The discharge of employees has the same disastrous effect that cutting price has. The merchant prince may not recognize the fact that the swarms of workmen coming and going through the gates of his works are his own ultimate customers, but the fact is none the less a fact for all that.

Fortunes have been made in providing for the wants of the rich, but not many, and none very large. The rich man pays a good price allowing a handsome profit to his provider—, sometimes. But he is not numerous enough to support the industry of a nation. The rich man if he is an industrialist is a middleman between one set of unrich consumers, and another of unrich producers, and the consumers in one case are the producers in another. To discharge workmen universally is to ruin customers universally. The merchant community that does this is like a number of drowning men grasping at each other. Its behaviour is futile, and suicidal, but inevitable in the present unorganized state of society.

No moral or class judgment is implied in all this. The unrich man nearly always thinks that the rich man makes poverty by the siezure of an unfair share of the produce of industry.

We cannot support him in this theory. The root cause of these troubles is simply ignorance, and the defective organisation which arises from it. The unrich man with his obvious ethics which he wrongly imagines to be the monopoly of his class, and his complete ignorance of economic principles, would if given the opportunity, make an even more complete mess of things than does the class he condemns. History provides a number of examples of the under dog siezing the supreme power by force, and as many of his return after an interregnum of bloody misrule to the system

he overthrew. Such examples, as history does provide of permanent uplift, are examples of a whole people co-operating to the same end. Our present situation is original only in its minor details.

Expansion and restriction of credit, like the hope and panic from which they usually spring, are difficult, but not altogether impossible to control. There is, to take the most conspicuous example, one power which can manufacture and destroy credit to an almost unlimited extent, regardless of the phases of the trade cycle, and at any time. It is a great nation with a long record of probity, and prosperity. The popular faith in a future, corresponding to its past, provides a foundation for the manufacture of credit more stable than a mountain of gold. The same power to a much smaller degree is possessed by local governments and municipalities, and to a still lesser degree by persons or firms of established reputation.

These can create credit even in times of depression. It is to their advantage to do so, because it is then that everything, including capital is cheapest (Capital is cheap when it is possible to borrow it at a low rate of interest. It is cheap during a depression to the man who can offer safe investments, because there is always a certain amount of surplus income seeking safe investment, and in these times safe investments are scarce).

The buying and manufacturing of a mass production shop should be done for the greater part during depression because :—

(a) It can be most cheaply done then.

(b) By so doing depression is relieved.

It should not buy or manufacture, or at least it should not buy more than it can help during a boom because :—

(a) Then materials are most expensive

(b) By so doing it adds to the general inflation and the height of the inevitable drop.

Self interest and the public interest point in the same direction for once, but unhappily it is not possible to follow them all the way. The time required fully to realize the profits of such a policy is too long. Nothing short of a nation could last out the depression. Credit would be exhausted before the boom materialized. Nevertheless it should be the ideal of the mass producer to guide his enterprise generally in the direction indicated above. He will not be able to do it, except on a very large capital, and even then only very imperfectly. Perhaps, the best compromise is to run generally on jobbing shop lines during the boom, and fall back on a mass production specialty when orders are not forthcoming.

At this stage Chapter II is to be read once more.

CHAPTER XX.

Organisation for mass production.

Choice of the Article to be Manufactured :— It is said that Mr. Ford, the American who now produces motor cars in millions, hesitated between the car, and a watch which could be sold for a rupee, and was afterwards unable to explain why he did not choose the latter. The watch is indeed an ideal article possessing all the essential qualities for mass production. They are :—

(a) Stability of form.

(b) A wide market.

(c) An elastic demand.

By STABILITY OF FORM we mean that the article should be one that, having been invented long since, has lost what Wells calls "the adventurous quality of youth". It has settled down for life, and the best solutions of its mechanical problems having been discovered is unlikely suddenly to be subjected to the competition of an improved, and patented article.

The very worst thing to select for mass production is some new invention. It is of prime importance where expensive machinery has to be installed, that it should not have to be altered or scrapped till it has earned the cost of installing it.

There have been no inventions of any importance in the watch since the middle of the eighteenth century,

and therefore as regards stability of form, no other machine can compete with it. On the other hand, consider the motor car.

The first successful cars appeared on the world's roads between 1890 and 1900, and it is by no means certain, in fact it is most improbable, that it has reached anything like its final form. The change speed gear for instance is most unsatisfactory. So is the self starter where that exists, the best of self starters being a very crude affair. The tyre is at the present moment in a state of transition to a new type, the baloon tyre. Front wheel brakes are being attempted successfully for the first time. It is very unlikely that petrol, a most dangerous, and increasingly expensive fluid will be the final form of fuel. A change of fuel is bound to bring in its train great changes in the engine. The differential serves its purpose only on a smooth dry road. We also are unable to understand why Mr. Ford chose the car. We strongly suspect him of the engineer's itch for invention, which is a most dangerous disease in the mass production shop. It should be eradicated everywhere except in the Jig and Fixture department.

THE WIDE MARKET goes almost without saying. We have already remarked that there is not much to be made in catering for the rich. The correct policy is to provide the poor with a luxury article, because the demand for poor men's luxuries is highly elastic. The demand for necessities is considerable but it has no elasticity, that is to say, a reduction in price will not

attract a great number of new buyers, since everyone is already supplied.

The demand for power driven pumps or even for hand pumps in India is probably very elastic. The pump is perhaps the most likely article in this country. It is an old and stable machine. It is not a necessity, or every ryot would have one.

At the same time it is a very desirable article in an agricultural country, and there can be little doubt that a twenty-five per cent reduction in any class of pump would tempt a vast number of people.

When the mass production article has thus been chosen, it should be redesigned from top to bottom with a view to eliminating.

(a) All fitting work.

(b) As many as possible of the parts adjustable for wear.

(c) As much as possible of the machining that must be done on intermittently cutting machines, such as the planer, slotter, and shaper.

As for "a" all that need be said, is that it is, a desirable consummation in all design, and especially so in work produced in large quantities by unskilled labour. The second principle is not so obvious, and must be applied with discretion. Experience does show, however, that when adjustment for wear becomes necessary, it is usually better to scrap the worn part, or even the whole machine and get a new one from the makers. We may

again refer to the typical machine the three rupee watch. There is no doubt that as soon as it begins to go wrong it had better be thrown away and a new one purchased in its stead.

The reciprocating machine is unsatisfactory because it wastes time and power; time because there is a back stroke, and power because of the friction resulting from inertia forces. Plane surfaces where they cannot be avoided should be arranged for the milling machine.

The redesigned machine should, of course, be exhaustively tested before it is finally adopted. There must be no change after production has commenced. A dozen machines, at least, should be made and driven to death to find out the weak points. This testing is an indispensable part of all design. No very satisfactory machine ever comes straight off the drawing board, no matter how clever and experienced its designer may be. Many possible improvements become obvious as soon as it begins to work, and have to be incorporated in the next one. It is quite necessary that the lesson of experiences should be learned as far as possible, before, not after mass production begins.

Limits:—For every hole that is to be bored, the workman is given two plug gauges; one the 'go' gauge which must go in easily, and the other the 'not go' gauge which must not go in at all. The sizes of these two gauges are the limits in that case. There are similar but as a rule lower, limits for the shaft which must fit in to the hole. The technical aspects of limits are beyond the

scope of this work. On economic grounds, however, it is necessary to warn the reader, that there is only one system of limits which he ought to consider. He is advised to commit to memory the formulae of the British Engineering Standards Association which he will find in its 'Publication No. 164. 1924'.

It is a task that will prove quite easy to an Indian student. It would be a serious error to adopt any of the numerous other limit systems which are to be found in various books, and that are advised by numerous firms of gauge makers.

The formulae permit the choice of any one of a number of grades of workmanship. It would take us too far aside from our present thesis to consider in any detail the choice of a grade. Naturally the nature of the article to be produced is a prime factor. If it is a cane crushing machine wider limits may be tolerated than are permissible for a watch. The usual mistake made is to select a finer grade of workmanship than is necessary or desirable. The variation in the work is shown by experience to be much less than the variation in the gauges. Many text books assume that the gauges should be of steel. That would be very nice, but it is better to have a large supply of cast iron gauges constantly renewed and checked, than a miserly supply of steel ones, many of them worn far beyond their proper sizes. The gauges for use in the workshop are made in the tool room which in the mass production shop must be a separate department. All

the skill of the establishment is concentrated in the hands of the comparatively few workmen to be found there.

Jigs :—These are frames made to envelop the part to be manufactured. Their object is to guide the operator in his work, and to save his time in fixing the parts in the machine tools. As in the case of gauges, we must refrain from a more exact description for fear the reader should think he has learned all about jigs. The design and making of jigs and fixtures has a highly developed technique of its own.

The design of the article, and the thorough testing of that design, must be preliminary work. So must the decision as to limits, and the making of gauges and templates. Jigs, and fixtures will continne to be modified and improved as long as production lasts. The decision as to:—

Piece Work Rates should be postponed for some considerable time till it is known with certainty, how long every operation should last. Any alteration of rates once announced has very evil effects upon the workmen. If the rate is lowered, the workmen naturally conclude that it is a mistake to work too hard, as it only leaves him in the end working twice as hard for the old wage. On the other hand, if the rate is raised, he sees the rise as a result of not working too hard before, and perseveres in that policy, in the hope that it will produce yet a further increase. When it is known how long every job requires of a workman, working with

the normal vigour of a time paid man; the wage for that time or the time itself is the "Standard Rate", and should be announced to the workmen as such, and never altered again unless there is a great change in the methods of manufacture. So far all methods of payment by results are the same.

There are three ways of dividing the profits arising from any saving of time.

Piece Work. The workman, provided his work passes the inspector, obtains for each operation, the full rate, no matter how quickly he does it. He does not receive any payment for work which fails to pass, but suffers no penalty except the loss of his own time. If he can do twice as much work as he formerly did, his wages are doubled, and so on. The employer's share is the saving of overhead charges, which is normally about the same as the increase of wages. On the whole this is the best system. The workmen understand it, and regard it as just. They are not so sure about :—

Bonus systems which allot in addition to the saving of overhead charges, a certain proportion of the extra wages also to the employer; in some cases a fixed proportion, and in others a proportion which is larger for large savings than for small ones.

The third system of **payment by results** has never obtained any vogue in the West, but it might well be cosidered in the East, as having the potentiality of largely mitigating the poisonous social effects of intensive

piece work, and as being congenial to the temperament of the people.

The Task System :— A certain number of the worker's operation is daily task. When it is completed, he is allowed to go, another workman of course taking his place at the machine. It is found in the West that the most powerful inducement that can be offered to a workman to work as quickly as he can is the prospect of quadrupled wages. But the Western worker has the stimulus of an invigorating climate, and is not as a rule, originally an agricultural worker. A mass production shop set up in the midst of an agricultural district in India, and working on the task system might solve many problems.

Appendix to Chapter XX.

A "Self Government and the Bread Problem"
"Man and Machine Power"
both by Captain J. W. Petavel contain some intersting discussions of Indian industrial problems.

B Extracted from a leading article in "Engineering" dated 13-2-25.

"It is by no means certain, however, that mass production methods when intelligently employed, have the soul destroying effect with which they are generally credited, nor do we believe that they could have been employed so successfully in the United States (of America) if that were the case.

That it is possible for these methods to be successfully utilized in the British Isles was amply demonstrated

during the war, as it was only by adopting mass production that we were able to attain an output of munitions far in excess of that of any other nation. It might be said however that this was a period during which we were content to sink our individuality, and for this reason special interest attaches to a paper on 'Some Notes on British Methods of Continuous Production' read by Mr. Frank G. Woolard before the Institution of Automobile Engineers on Tuesday last. The paper describes the very successful application of methods of continuous production—or mass production as it is generally called in America—in the engine works of Messrs. Morris Motors Limited, and reading between the lines of this paper it is evident that in this case at any rate, the individualism of the worker—to whatever extent it may actually exist—has not been found incompatible with the successful working of the system.

The extent to which continuous production methods can be applied successfully in the case of any given firm is dependent entirely on the market of a particular product and mistakes in the past have generally taken the form of excessive capital sunk in plant without sufficient assurance that the products would have a ready sale. In other words it is essential that a potential demand should exist before laying down plant for continuous production, and although it is doubtless possible to create a demand in certain classes of goods simply by lowering the price of an article, it must be remembered that the requisite plant is of necessity

extremely expensive, and that on this account no lowering of the price can result until the sales have reached a high figure. It will generally be found that where continuous production methods are being most successfully applied as in the United States, improvements in the productive plant have taken place gradually, and have only been effected when the increasing sales have shown that such improvements were warranted.

It will be evident from what we have said, that the first essential of production on such lines is that the article manufactured shall have achieved a firm position in popular favour, and that it shall have been tried out by the actual user to such an extent, that no reasonable doubt can exist as to essential soundness of its design. From this point of view the policy of so many of our automobile firms of introducing entirely new models at frequent intervals, is little short of suicidal, as it means in essence that the older models on which the only judgment that counts—that of the purchasing public—have been passed are withdrawn, and that for some time to come sales will be effected on the basis of the reputation of the firm rather than on the quality of the article sold. It may appear from this that the adoption of continuous production stultifies improvements in design, but although this danger undoubtedly exists, its importance can easily be over estimated. That it is quite possible to introduce improvements in design under these conditions of manufacture is amply borne out by

an examination of the products in successive years of one or two of the best known firms manufacturing along these lines, but in making such an examination, it is necessary to bear in mind that the original product was essentially sound; and that in consequence any additional improvements have been in the nature of refinements"

CHAPTER XXI.

Contract and specification.

Contract and specification:—Although a competent legal counsel is necessary in all matters connected with a contract, a fairly good knowledge of the law is useful in assisting the Manager or Engineer of a firm to avoid serious mistakes and difficulties.

Policy to be followed:— (1) Determine how far the contractors are to be made responsible for the final results.

(2) The principal purpose of a specification is to convey clearly the ideas and intentions of the designer of a plant. An engineering specification is almost always a part of a contract, either directly or by reference. It is meant to describe labour, material or results desired by a purchaser, with the object of enabling competitive bidders to estimate with equal facility upon the amount of a contract.

(3) Do not burden the specification with restrictions of the contractor's complete latitude in utilizing his own experience and ingenuity for the purpose of securing the best, speediest and most economical realization wherever practicable. Remember that every unnecessary or unfair clause in a specification has its part in limiting competition and lowering the standard of honesty among contractors. Avoid specifying proprietary articles

or material as far as possible in order not to restrict competition.

(4) The art of drawing specification is acquired by practice and it presupposes a thorough knowledge of the subject matter in hand. In drawing up a specification however it is very desirable, that many specifications covering similar or identical subject matter should be available for consultation. Thus standards of recognized Engineering Societies should be followed unless local conditions prohibit them, and manufacturer's standards should be followed if low bids are to be expected.

(5) All high quality materials are costly. Hence unless the best materials and workmanship are necessary in spite of their higher cost, adopt some fair commercial standard to avoid waste.

(6) Avoid unduly long description of minor items by demanding "reasonably" good articles for the purpose.

Specification. :— A specification is a written description of works to be done.

Form of Specification. :— (1) All specifications should be clear, concise, direct, definite, conclusive and legally sound and should be in convenient form for reference purposes.

(2) Number the paragraphs or clauses of all specifications for convenience of reference and allot a separate clause for every item of the work.

(3) The magnitude and importance of the work determine the degree of the details of the specification. After describing the object of the specification and stating the general conditions, amplify the form so far as may be necessary in particular cases under the following heads:—

I. Summarized Description of principal Characteristics and Conditions of Service.
II. Style and description of Apparatus ; Details of Construction.
III. Dimensions, Weights, Drawings and Schedules.
IV. Work to be done by other Contractors.
V. Performance and Tests.
 (a) Performance which may be checked by mere observation.
 (b) Factory Tests.
 (c) Performance and Tests after Erection.
VI. Workmanship and Finish.
VII. Packings, Marking, Shipping and Delivery.
VIII. Inspection and Rejection.
IX. Guarantees.
X. Conditional Payments. (The details of conditional payments depending upon results of inspection and tests).

When the capacity of the machines, as described beforehand, is known, the capacity, type and number of machines are determined and a complete schedule of the machines required should be made out. Following

this, a brief specification for each class of machine required should be drawn up. The SPECIFICATION amongst other things should make clear :—

(i) The class of machine and number of machines required and at times the name of the manufacturer.

(ii) The productive capacity of the machine.

(iii) The r. p. m. and size of driving shaft proposed or other means of power-drive for the machine.

(iv) Whether driving pulley, counter shafting or other driving accessories are to be provided with the machine.

(v) A list of all accessories and spare parts, if necessary, required.

(vi) The number of working drawings (not fewer than 3 copies) of the machine and copies or working instruction required.

(vii) Full instruction for the packing and delivery of the machine and its equipment.

Points to be covered in specification :— The specification should, so far as possible, cover the following points :

In preliminary specifications:—

(1) These specifications are intended to furnish such information to the Bidders as will enable them to prepare detail plans upon which to give prices. Should

any Bidder consider the requirements of these specifications prohibitive to the free exercise of his skill, any suggestions made by him will be duly considered.

(2) In comparing proposal, due consideration will be given by the company to availability, reliability, simplicity, cost of maintenance and quickness of delivery.

Before a contract is awarded prepare the **final specifications** in the light of the information obtained from the contractors in response to queries (1) and (2) above,

(3) The tenders are to be in sealed covers and the Engineer should agree to treat all drawings submitted by the bidders as confidential and that he will not show such drawings to other manufacturers whether they are tendering under this specification or not.

(4) There should be definition of titles describing the parties to the contract such as 'Engineer' etc.

(5) The names of the persons concerned and their respective powers should be stated.

(6) The name of the place where the work is to be done or the materials are to be delivered, should be stated.

(7) The contractor shall be responsible for the correctness of all drawings even after they are approved by the Engineer.

(8) Materials ordered or work commenced prior to the approval of the drawings will be at the Contractor's risk.

(9) No approved drawing may be changed without the approval of the Engineer.

(10) The Contractor shall inspect the work of other contractors whose work affects his, and shall notify the Engineer of anything which injuriously affects his work. The Contractor shall give these other contractors the privilege of inspecting his work in so far as it affects the acceptance of their work.

(11) Contractor shall not drill or in any way impair the strength of buildings or structures except with the written consent of the Engineer.

(12) All work shall conform to the requirements of the Insurance Company and to all Government regulations.

(13) The Standardization Rules of the. I. E. E. and other similar documents should be followed wherever possible.

(14) The provisions of the preliminary specification and those subsequently agreed upon between Company and Bidder should be incorporated as part of the final or contract specification.

Questions of import duty, freight and carriage to site should not be left to chance and shipping weights and dimensions should also be asked for, especially where transport over mountains or rough country is involved. Foundation plans should always be asked for. Also terms of payment should be specified. It

is usual to pay 10 % on setting to work and the remainder after a period of 3 or 6 months' working, in large foreign contracts a proportion is often paid on receipt of bill of lading.

Points to be Covered in Contract.—

(1) The actual contract in all important cases should be prepared by a competent lawyer in consultation with the Engineer.

(2) The work must be performed in such a way as not to interfere with safety and continuity of service.

(3) The Contractor shall not transfer the contract to others without permission.

(4) Time of commencement of work, rate of progress and date of completion.

(5) The character of the method and appliances to be used and grade of workmen to be employed.

(6) Arbitration and settlement of disputes.

The following Specimen may be taken as a fair model.

FORM OF MODEL GENERAL CONDITIONS OF CONTRACT FOR ELECTRICAL WORKS.

(Adapted from the form of the Chartered Institution of of Electrical Engineers, London).

Definition of Terms

1. In construing these General Conditions and the annexed Specification, the following words shall have the meanings herein assigned to them unless there is something in the subject or context inconsistent with such construction :—

The "Purchaser" shall mean The Honourable Maharaja Sir Krishna Narayan Bhupa Bahadur K.C.S.I. and shall include his legal personal representatives, successors and assigns.

The "Contractor" shall mean the Tenderer whose Tender shall be accepted by the Purchaser, and shall include the Tenderer's legal personal representatives, successors and assigns.

The "Sub-contractor" shall mean the person named in the Contract for any part of the work or any person to whom any part of the Contract has been sub-let with the consent in writing of the Engineer and legal representatives, successors and assigns of such person.

The "Engineer" shall mean Prof. Bhim Chandra Chatterjee, B. Sc., M. I. E. E. or any other Engineer for the time being, or from time to time duly authorized and appointed in writing by the purchaser to supervise the carrying out of the Contract.

"Plant", "Work" or "Works" shall mean and include plant and materials to be provided and work to be done by the Contractor under the Contract.

The "Contract" shall mean and include the General Conditions, Specification, Schedules, Drawings, Form of Tender, Covering Letters, Schedule of Prices, and the Agreement to be entered into.

The "Specification" shall mean the specification annexed to these General Conditions.

The "Site" shall mean Rangpur, Nawabganj in Bengal, India, and any other place in the said Territory where Work is to be executed under the Contract.

"Tests on Completion" shall mean such tests as are prescribed by the Specification to be made by the Contractor before the plant is taken over by the Purchaser.

"Commercial Use" shall mean that use of the Work which the Contract contemplates or of which it is to be commercially capable.

"Month" shall mean Calendar month.

"Writing" shall include any manuscript, type-written or printed statement, under or over signature or seal, as the case may be.

Words importing persons shall include Firms and Corporation.

Words importing the singular only shall also include the plural and vice versa where the context requires.

Contractor to inform himself fully

2. The Contractor shall be deemed to have carefully examined the general conditions, specifications, schedules and drawings and in cases of doubt, submit the doubtful points in writing to the Engineer, and have his doubt removed. The purchaser shall pay for any alteration of the work necessitated by reason of inaccurate information supplied by the Engineer to the Contractor.

Contract and Bond

3. The Contractor and the purchaser shall enter into a sealed agreement for the proper fulfilment of the contract and the contractor shall duly provide necessary sureties. All

expenses for completing and stamping the agreement shall be paid by the purchaser.

Contract Drawings

4. The Contractor shall submit, to the Engineer for his approval, on or before the dates mentioned in the Specification, a set of blue prints of the Drawings of the General Arrangement as set out therein, and of such Detail Drawings as may be reasonably necessary.

Within fourteen days of the receipt of such blue print, the Engineer shall signify his approval or otherwise of the same.

Within fourteen days of the notification by the Engineer to the Contractor of his approval of such blue prints two sets, in ink on tracing cloth or ferrogallic prints mounted on cloth, of the Drawings as approved shall be supplied to him by the Contractor and be signed by him and by the Contractor respectively and be thereafter deemed to be the "Contract Drawings".

These Drawings when so signed shall become the property of the Purchaser and be deposited with the Engineer, and shall not be departed from in any way whatsoever except by the written permission of the Engineer as hereinafter provided. During the execution of the works, one of the sets of Drawings shall be available for reference on the site.

In the event of the Contractor desiring to possess a signed set of Drawings he shall supply three sets

instead of two sets, and in this case the Engineer shall sign the third set and return the same to the Contractor.

The Contractor shall supply from time to time at schedule rates single copies of additional Drawings for the purposes of the Contract.

The Engineer, or his duly authorized representative, whose name shall have previously been communicated in writing to the Contractor, shall have the right, at all reasonable times, to inspect drawings of any portion of the Work.

If the Contractor shall not submit the blue prints referred to in the first paragraph of this Clause within the time specified, or subsequently within seven days after, the Purchaser or the Engineer shall, in writing, have required him so to do, and if the delay shall not have been occasioned by the Purchaser or the Engineer, or any other Contractor, or other reasonable cause, the Purchaser shall be entitled by notice in writing within seven days from the expiry of the said seven days aforesaid to avoid the Contract and the Purchaser upon the giving by him of such notice shall not be liable to or for any claim or demand from the Contractor in respect of Work then already done or material furnished, or in respect of any other matter or thing whatsoever in connection with the contract, but nothing contained in this Clause shall deprive either party of any rights or claims he may have or have had against the other by reason of the non-compliance by such other with any of the provisions of this Clause.

Sub-letting of contract

5. The contractor shall not, without the consent in writing of the Engineer, assign or sublet his contact or any substantial part thereof nor make any sub-contract with any persons for execution of any portion of the work other than for raw materials or for minor details.

Manner of Execution
Quality of Material&c

6. The Plant shall be manufactured, constructed, provided, put in position, and maintained in the best and most substantial and workman-like manner, and with materials of the best or of approved qualities for their respective uses.

Power to vary or omit work

7. The contractor shall not alter in any way any of the work accepted as directed in writing by the Engineer. The Engineer shall have full power from time to time during the execution of the contract by notice in writing to instruct the contractor to alter, amend, omit, add to or otherwise vary any of the work without prejudice to the contract to the extent of an increase or decrease of not more than 10 °/₀ of the total price payable under the contract, unless consented in writing, and the contractor shall carry out such alterations amendments, omissions, additions or variations and be borne by the same conditions as originally agreed upon. The necessary difference of price should be made in the contract price.

Engineer's Supervision

8. All the Works shall be carried out under the direction and to the reasonable satisfaction of the Engineer. The Contractor

shall be responsible for the correctness of the positions, levels, and dimensions of the Works according to the Drawings, notwithstanding that he may have been assisted by the Engineer in setting out the same.

Engineer's Decisions.

9. In respect of all matters which are left to the decision of the Engineer, including the granting or withholding of Certificates, the Engineer shall, if required so to do by the Contractor give in writing a decision thereon, and his reasons for such decision. All decisions of the Engineer shall be subject to the right of Arbitration reserved by these General Conditions.

Contractor's Representative and Workmen

10. The Contractor shall employ at least one competent representative, whose name or names shall have previously been communicated in writing to the Engineer by the Contractor, to superintend the erection of the Plant and the carrying out of Works. The said representative, or if more than one shall be employed, then one of such representatives, shall be present on the Site during working hours, and any written orders or instructions which the Engineer or his duly authorized representative, whose name shall have been previously communicated in writing to the Contractor, may give to the said representative of the Contractor shall be deemed to have been given to the Contractor.

The Engineer shall be at liberty to object to any representative or person employed by the Contractor

in the execution of or otherwise about the Works who shall misconduct himself or be incompetent or negligent, and the Contractor shall remove the person, so objected to, upon receipt from the Engineer of notice in writing requiring him so to do.

Liability for Damage

11. Until the Plant shall be or be deemed to be taken over, the Contractor shall be liable for and shall be deemed to have indemnified the Purchaser in respect of all damage or injury to any person or to any property of the Purchaser or of others occasioned by the negligence of the Contractor or his Workmen or sub-contractors or by defective design, work, or material, but not otherwise.

Provided that the Contractor shall not be liable under the Contract for any loss of profit or loss of Contracts or any claims made against the Purchaser not already provided for in the Contract, nor for any damage or injury caused by or arising from the acts of the Purchaser or of others, or (save as to damage by fire as hereinafter provided) due to circumstances over which the Contractor has no control.

The Contractor shall be deemed to have indemnified and saved harmless the Purchaser against all actions, suits, claims, demands, costs, or expenses arising in connection with injuries suffered prior to the date when the Plant shall have been taken over under Clause 19 herein by persons employed by the Contractor on the Works whether at Common Law or any other Statute in force at the date of the Contract dealing with

the question of the liability of employers for injuries suffered by employees.

In the event of any claim being made, or action brought against the Purchaser involving the Contractor and arising out of the matters referred to and in respect of which the Contractor is liable under this Clause, the Contractor shall be immediately notified thereof, and he shall, with the assistance, if he so require, of the Purchaser, but at the sole expense of the Contractor, conduct all negotiations for the settlement of the same, or of any litigation that may arise therefrom. In such case the Purchaser shall, at the expense of the Contractor afford all available assistance for any such purpose.

Insurance.

12. The Contractor shall insure such Plant and Materials ordered for the Plant as may for the time being be upon the Site, and shall keep them insured against destruction or damage by fire for the full value of such Plant and Materials until the same be taken over under Clause 15.

Replacement of Defective Work or Materials

13, If during the progress of the Work the Engineer shall decide and notify in writing to the Contractor that the Contractor has executed any unsound or imperfect Work or has supplied any Plant or Materials inferior in quality or quantity to those specified the Contractor on receiving details of such defects or deficiency shall, at his own expense, within seven days of his receiving the notice, proceed to alter, reconstruct,

or remove such Work, or supply fresh materials up to the standard of the specification, and in case the Contractor shall fail so to do, the Purchaser may, on giving the Contractor seven days' notice in writing of his intention so to do, proceed to remove the Work or Materials complained of, and, at the cost of the Contractor, perform all such Work or supply all such Materials, provided that nothing in this Clause shall be deemed to deprive the Purchaser of or affect any rights under the Contract which he may otherwise have in respect of such defects or deficiencies.

Terms of Payment

14. Subject to any deductions which the Purchaser may be authorized to make under the Contract, the Contractor shall be entitled, upon the certificates of the Engineer, to payments by the Purchaser by instalments in accordance with the following provisions.

(i) As the Works progress, instalments of 80 per cent of the Contract value as certified by the Engineer of the Plant from time to time delivered or Work executed on the Site.

(ii) The remaining 20 per cent referred to herein as "Retention Money," in respect of each distinct section or part of a section of the Works, as follows :—

10 per cent at the expiration of one month after the Plant shall have been taken over by the Purchaser ; and the remaining 10 per cent at the expiration of twelve months thereafter.

If at the time at which either of the said instalments of the Retention Money becomes payable under the Contract there are minor defects in the Plant which are not of such importance as to affect the full Commrcial Use of the Plant, then the Purchaser shall be entitled to retain only such part of the instalment then due of the Retention Money as represents the cost of making good such minor defects, and any sum so retained shall become due upon such minor defects being made good.

In cases where the Contractor is prevented for any period from causes for which the Purchaser is responsible either, first, from delivering the Plant to the Site, or, secondly, from proceeding with the erection of the Plant which he has already delivered to the Site, the Purchaser shall bear the cost of storage and protection, including Fire Insurance, of the Plant and Materials during such period. In the first case, the Purchaser shall make the payment of 80 per cent, therefor (as if the Plant had been delivered) within one month from the date of notification, by the Contractor to the Purchaser, that the Plant is ready for delivery, opportunity to be given to the Purchaser within that time to satisfy himself that the Plant is so ready and that all portions thereof are suitably and sufficiently marked as being his property; and the Retention Money shall be payable as above specified provided that if the aforesaid period of delay shall exceed two months the first instalment of 10 per cent. of the Retention Money shall be payable at the expiry of the said two months

from the date of notification aforesaid and the second instalment thereof within fifteen months from the date of such notification aforesaid, and such payments shall be reduced by an amount to be agreed upon to cover the cost of delivery, erection, and maintenance. In the the second case, the Retention Money shall be payable as above specified provided that if the aforesaid period of delay shall exceed two months the first instalment of 10 per cent. of the Retention Money shall be payable at the expiry of the said two months, and the second instalment thereof of the Retention Money within fifteen months from the date from which the instalment of 80 per cent. became payable, and such payments shall be reduced by an amount to be agreed upon to cover the cost of erection and maintenance.

Certificates of Engineer

15. Every application to the Engineer for a Certificate must be accompanied by a detailed claim (in duplicate) setting forth in the order of the Schedule of Prices, particulars of the Plant delivered and Work executed to the date of claim, and the Certificate as to such Plant and Work as is in the reasonable opinion of the Engineer in accordance with the Contract shall be issued within 14 days of the application for the same.

The Engineer may by any Certificate make any correction or modification in any previous Certificate which shall have been issued by him, and payments shall be regulated and adjusted accordingly.

Certificate not to Affect Rights of the Purchaser or Contractor.

16. No Certificate of the Engineer on account, nor any sum paid on account by the Purchaser nor any extention of time for the execution of the Works by the Contractor shall affect or prejudice the rights of the Purchaser against the Contractor, or relieve the Contractor of his obligations for the due performance of the contract, or be interpreted as approval of the Work done or of the Materials supplied, and no Certificate shall create liability in the Purchaser to pay for alterations, amendments, or variations not ordered in writing by the Engineer, or discharge the liability of the Contractor for the payment of damages whether duly ascertained or certified or not or of any sum against the payment of which he is bound to indemnify the Purchaser, nor shall any such Certificate nor the acceptance by him of any sum paid on account or otherwise affect or prejudice the rights of the Contractor against the Purchasee.

Test on Completion.

17. On the completion of the Works on the Site substantially in accordance with the Contract the Cantractor shall give the Engineer notice in writing thereof, and before making the "tests on completion" shall give the Engineer seven days' notice in writing of the date on which he will make the said tests of the work in accrdance with, and in the manner prescribed by, thc Specification.

Unless otherwise agreed the Contractor shall commence such tests upon such date and shall carry

out the same, and if the Engineer or his authorized representative, whose name shall previously have been communicated in writing to the Contractor, shall attend such tests shall be carried out in his presence.

If the Engineer or his said representative shall fail to be present at the said tests the Contractor shall be entitled to proceed in his absence, and the said tests shall be deemed to have been made in his presence.

If any portion of the Plant fail under the tests to fulfil the Contracts, tests of the faulty portions shall, if required by the Engineer, or by the Contractor, be repeated within a reasonable time upon the same terms and conditions, and upon payment to the Purchaser of all reasonable expenses to which he may be put by such tests.

If the "tests on completion" be not successfully made by the Contractor within one month after the date fixed by the Contract for the completion for commercial use or for testing of the plant, and if, in the opinion of the Engineer, the tests are being unduly delayed the Engineer may, in writing, call upon the Contractor under seven days' notice to make such tests, and on the expiry of such notice such tests shall forthwith be made by the Contractor.

If, after the expiry of the said notice from the Engineer the Contractor neglects to make such tests, the Engineer may proceed to make such tests himself at the Contractor's risk and expense.

Rights of Use before Tests.

18. If the Contractor neglects to make the tests on completion by the dates stipulated by the Contract, the Purchaser shall nevertheless have the right of using the Plant at his own expense until the "tests on completion" are successfully carried out, but such use shall, provided the Plant is used in a proper and normal manner, be at the Contractor's risk.

At any time after the completion of the Works, or any portion thereof as the case may be, on the Site the Purchaser may, pending any Arbitration under the Contract, use any portion of the Plant reasonably capable of being used, but in such case the Contractor shall be entitled to be paid in respect of any Plant commercially used, a sum equal to 5 per cent. per annum (according to the period of the user) upon the amount withheld or deducted in respect of such Plant.

Time of taking over

19. The Plant, when erected on the Site, shall be deemed to have been taken over by the Purchaser when the Engineer shall have certified in writing that the Plant has fulfilled the Contract Conditions and such Certificate shall not be unreasonably withheld, nor shall the Engineer delay the issuing of his taking-over Certificate on account of minor omissions or defects, which do not affect the Commercial Use of the Plant, provided always that the Contractor undertake to make good such omissions and defects at the earliest possible moment.

Interference with Tests

If by any act of the Purchaser or of the Engineer, or by the use of the Plant as provided in Clause 17, the Contractor shall be prevented from carrying out the "tests on completion" within two months from the date of the notice of completion specified in clause 17, unless in the meantime the Plant shall have been proved not to be substantially in accordance with the Contract Conditions, the Plant shall be deemed to be taken over as on the last day of the said two months and payment to the Contractor shall be made as if final satisfactory "tests on completion" had taken place, but nevertheless the Contractor shall make the said tests during the period provided for maintenance as and when required by the Engineer upon fourteen days' notice in writing': and the obligations and liabilities of the Contractor in connection with such tests shall be the same as his obligations and liabilities in connection with the tests specified in Clause 17, provided that the Purchaser shall pay the extra expense of such tests.

Rejection of Defective Work

20. If the complete Plant, or any portion thereof before it is taken over under Clause 19 be defective, or fail to fulfil the requirements of the Contract, and the Contractor receive from the Engineer notice setting forth particulars of such defects or failure, the Contractor shall forthwith make the defective Plant good, or alter the same to make it comply with the requirements of the Contract. Should he fail to do so within a reasonable time, the

Purchaser may reject and replace, within a reasonable time and at a reasonable price under Competitive Conditions, at the cost of the Contractor, the whole or any portion of the Plant, as the case may be, which is defective or fails to fulfil the requirements of the Contract. The Contractor's full and extreme liability under this Clause shall be satisfied by the payment to the Purchaser of the extra cost, if any, of such replacement, such extra cost being the ascertained difference between the price piad by the Purchaser, under Competitive Conditions, for such replacement and the Contract Price for the Plant so replaced, and the repayment of any sum paid by the Purchaser to the Contractor in respect of such defective plant. Should the Purchaser not so replace the rejected Plant within a reasonable time, the Contractor's full and extreme lbility under this Clause shall be satisfied by the repayment of all moneys paid by the Purchaser to him in respect of such Plant. If such supply of defective Plant shall have caused delay in the completion of the Contract, so as to give rise to a claim for damages on the part of the Purchaser, nothing contained in this Clause shall interfere with or prejudice any rights of the Purchaser with respect to such claims, but such claims shall not, in the case of Plant replaced by the Purchaser, as herein provided, exceed 25 per cent. of the Contract value of the Plant so replaced.

21. For a period of twelve calendar months after the Plant has been taken over under Clause

Maintenance.

19 the Contractor shall be responsible for any defects that may develop under the Conditions provided for by the Contract, and under proper use, arising from faulty materials, design, or workmanship in the Plant, but not otherwise, and shall remedy such defects when called upon so to do by the Engineer, who shall state in writing in what respect any portion is faulty.

If it becomes necessary for the Contractor to replace or renew any defective portions of the Plant under this Clause, the provisions of this Clause shall apply to the portions of the Plant so replaced or renewed until the expiration of six months from the date of such replacement or renewal or until the end of the above-mentioned period of twelve months, whichever may be the later. If any defects be not remedied within a reasonable time, the Purchaser may proceed to do the work at the Contractor's risk and expense, but without prejudice to any other rights which the Purchaser may have against the Contractor in respect of such defects.

If the replacement or renewals are of such a character as may affect the efficiency of the Plant, the Purchaser shall have the right to give to the Contactor within one month of such replacement or renewal notice in writing that "tests on completion" be made, in which case such tests shall be carried out as provided in Clause 17 hereof. Should such tests show that the Plant sustains the guarantees given in the Contract the

cost of the tests shall be borne by the Purchaser. Should the guarantees not be sustained the cost of the tests shall be borne by the Contractor.

All inspections, adjustments, replacements, or renewals carried out by the Contractor during the maintenance period shall be subject to the same General Conditions as the Contract.

Until the final Certificate shall have been issued, the Contractor shall have the right of entry, at his own risk and expense, by himself or his duly authorized representatives, whose names shall have previously been communicated in writing to the Engineer, at all reasonable working hours, upon all necessary parts of the Works for the purpose of inspecting the working and the records of the Plant and taking notes therefrom. and, if he desire, at his own risk and expense, making any tests, subject to the approval of the Engineer which shall not be unreasonably withheld.

Departmental work.

22. If it be desirable that the work is to be carried on departmentally and the contractor is required to supply the necessary plant and material according to specification agreed upon, the said contractor shall supply all working drawings in full detail whenever required, or when called upon by the Engineer or his representative to do so and such part of the Clauses afore-mentioned as regards retention-money, as can apply uuder the altered conditions, shall be deemed to

be applicable. The list, on completion, may be made by the Engineer or his repesentative or in case of need and when there is dispute by the arbitration referred to, the payment of the retained money being regulated by the results of such tests in the same manner as has been provided for, when the erection of the work is entrusted to the contractor with such alterations as may be required under the altered conditions and may be agreed to by the parties.

Arbitration

23. If at any time any question, dispute, or difference whatsoever shall arise between the Purchaser or the Engineer and the Contractor upon, or in relation to, or in connection with the Contract, either party may forthwith give to the other notice in writing of the existence of such question, dispute or difference, and the same shall be referred to the arbitration of a person to be mutually agreed upon, or, failing agreement, to some person appointed by the The Electrical Adviser to the Government of India or any other competent person. This submission shall be deemed to be a submission to Arbitration within the meaning of the Indian Arbitration Act, or any statutory modification thereof.

The award of the Arbitrator shall be final and binding on the parties. Upon every or any such reference, the costs of and incidental to the reference and award respectively shall be in the discretion of the Arbitrator, who may determine the amount thereof, or

direct the same to be taxed as between solicitor and client, or as between party and party, and shall direct by whom and to whom, and in what manner the same shall be borne and paid.

Work under the Contract shall, if reasonably possible, continue during the Arbitration proceedings, and no payments due or payable by the Purchaser shall be withheld on account of such proceedings.

For specification and the lay-out of the building the following pcints must be remembered:—

(a) A high speed driving of shaft is advantageous and economical.

(b) The economic limit of belt speed are 2000-4000 ft./ min.

(c) Abnormally tight belts and heavy slow movements should be avoided.

(d) Try as far as possible to take heavy powers from the shafting at its ends and remote from the driving pulleys.

(e) That the shaft has a true alignment i.e. it rolls only and does not twist when running.

(f) Shafting speeds of 200-400 r.p.m. are distinctly economical.

(g) Long belt drives (up to 20 ft. from pulley to pulley) ensures sweet running and absence from belting troubles attending a short drive.

Such an arrangement enables narrower belts to be used for transmission of a given power and keeps the cost of belting lower in the long run, though initially more expensive.

(h) Use stiff supports for pulleys, balanced pulleys, and long ring lubricated or ball bearings of modern type to obviate the attendant losses of shaft driving.

Where satisfactory solutions to all the points summed up in this section are forthcoming the machinery should be installed and got to work with the minimum delay and difficulty.

The following **forms of specification** have been taken from :—Electrical Engineering Practice by J. W. Meares and R. E. Neale.

The purchaser should give the following details when asking for tenders, for Steam Plant and an Oil or Gas Plant unless for any particular item he thinks it advisable to leave the matter to the discretion of the tenderer ; in which case the latter should be asked to supply the necessary data in his tender :—

Specification of Generators

(a) Normal full load output in kilowatts.

(b) Maximum overload and duration 25 °/₀ overload for two hours and 100°/₀ overload momentarily.

(c) Terminal volts at full load.

(d) Whether direct coupled or, if not, how driven.

(e) Revolutions per minute, according to drive and type of prime mover.

(f) Number of poles, if material to the case.

(g) Whether for parallel running with machines already at work ; if so, full description of same should be given.

(h) If the neutral point or neutral wire is to be connected to earth the fact should be stated.

(i) Minimum efficiency at full, $\frac{3}{4}$, $\frac{1}{2}$ and $\frac{1}{4}$ load and at 25% overload.

(j) Temperature rise over surrounding air of various components, after run of 6—10 hours at full load and also after subsequent run at specified overload immediately following ordinary test run. Also whether temperature is to be determined by thermometer or resistance. Maximum air temperature of locality should be stated in the case of plant for the use in the tropics.

C. C. Machines :—

(k) Winding—series, shunt, or compound.

(l) Rise of pressure from no-load to full-load for compound-wound machines.

(m) Extent of required pressure variation by means of field regulation in shunt-wound machines.

(n) Sparkless commutation ; if commutating interpoles are required the fact should be stated.

A. C. Machines :—

(o) Number of phases—single or 3-phase generally.

(p) Periodicity (standard 50 cycles)

(q) Output in K.V.A at expected power factor 8·5 as well as in K.w. at unity P. F.; the machine to conform to specified temperature rise under the conditions of the lower P. F.; i. e. with the larger current.

(r) Pressure regulation under conditions of non-inductive and inductive load at P. F. = 1 and 0·8.

(s) Excitation required, and whether exciter is to be driven from the alternator shaft or separately.

Accessories :—Field regulators ; cables connecting to switch board ; holding-down bolts : spare parts, viz. armature coils or extra armature, brushes, and gear ; bearing bushes : tools. If belt-driven, pulley, slide rails, belt tightener.

Motors,—In the case of motors the purchaser should state, or ascertain from tenderers :—

(a) Whether open, ventilated, or enclosed type is to be supplied.

(b) Whether to be rated for continuous or intermittent working, and the normal B. H. P. on this basis.

(c) Maximum overload and duration, as in the case of generators.

(d) Terminal volts.

(e) Whether direct coupled and, if not, whether driven by belt, rope, helical gearing, worm gearing, etc. In the case of gearing down, the required reduction should be stated. If ball bearings or roller bearings are required the fact should be stated.

(f) Revolutions per minute, according to drive and type of machine to be driven; allowable limits of variation at different loads, or required speed variation, as the case may be; size of driving pulley.

(g) Number of poles, if it matters.

(h) Required starting torque, if it matters.

(i) Whether system on which motor is to work is connected to earth at neutral point.

(j) Efficiency and temperature rise as in the case of generators.

C. C. Motors :—

(k) Whether series, shunt, or compound-wound: and whether required with commutating interpoles, as for variable speed motors.

A. C. Motors :—

(l) Number of phases and periodicity, as in the case of generators.

(m) Whether synchronous, commutator, or induction type, and in the last named case, whether squirrel-cage or slip-ring. In the case of

synchronous motor, separate excitation is required and must be arranged for.

(n) Starting current should be stated in tender.

(o) Power factor at full, $\frac{3}{4}$, and $\frac{1}{2}$ load should be stated in tender.

Accessories :—Starting and regulating gear ; no-load and overload release; cables from motor to starter, etc. ; spare parts, as in the case of generators ; holding-down bolts ; tools. If for belt driving, pulley, slide rails, belt tightener.

Transformers.—

(a) Whether single-phase or 3-phase ; periodicity.

(b) The required output on the secondary side should be given in K.w or, if the load to be supplied is inductive, in K.V.A. The nature of the load, or the probable P. F. at secondary terminals, should be stated.

(c) Pressure of supply at the primary terminals ; required pressure at the secondary terminals.

(d) Whether oil-insulated or not. Oil insulation is generally used for extra high pressures and in large sizes, where the heat generated can be carried away by water pipes in the oil space. Small transformers depend on the dielectric on the coils.

(e) Whether artificially cooled, and (if so) whether by air or water.

Pressure regulation at full load on P. F. of unity and 0·8.

(g) Open circuit losses.

(h) Over all efficiency at full, $\frac{3}{4}$, $\frac{1}{2}$, and $\frac{1}{4}$ load.

(i) If special tappings for variable pressure are required.

Accessories :—Transformer oil : spare coils ; circulating fan or pump for cooling : piping.

Storage Batteries.—

(a) The number of cells, including regulating cells, must be stated, or the working pressure of the installation.

(b) The required capacity in ampere-hours must be given. This varies with the rate of discharge. It is usual to specify the capacity when the battery is discharged in 5 or 10 hours and also the maximum safe discharge current for 1 hour. Alternatively, the conditions of load and probable hours of working may be specified.

(c) Specify by whom the stands are to be supplied, painted, and erected.

(d) Specify by whom the electrolyte is to be supplied, exact a guarantee as to its purity.

(e) Ascertain the normal and maximum charging rates.

Accessories :—Hydrometers for specific gravity ; cell testing voltmeter 1—4V ; lamp to slip between

plates for cell inspection; connection to switchboard; spare plate sections. Lead-burner's outfit, if necessary; tank for acid mixing; water distilling apparatus; anti-sulphuric enamel for stands, etc. Note the E. M. F. required for cell charging. If necessary a booster can be used.

Switchboards—.

(a) The number of panels and apparatus required on each, and the current and pressure, should be stated. These may comprise the following:— (i) Panel for each generator, with ammeter (reading to about double the current of the generator); voltmeter (standard pressure central on scale); main switch or circuit breaker; cut-outs, fusible or automatic; reverse current circuit breaker, if required, shunt regulating switch and resistance, unless placed on separate pillar; wattmeter if required. For large currents shunted ammeters or current transformers may be required; and for high-pressure voltmeters, transformers also. (ii) Panel for each feeder, similarly provided (according to the load on each) with ammeter, voltmeter, switches, cut-outs. Where two sets of bus-bars are provided and kept at different potentials, change-over switches are required on generator and feeder panels. (iii) Total output panel, between generators and feeders, with ammeter

and wattmeter for maximum output and also station voltmeter. (iv) Neutral panel on 3-wire systems, with centre-zero ammeter to show out-of balance current. The earth connection of neutral may be taken from this panel, and a current-limiting resistance may be added if necessary to keep the earth current down. (v) Balancer panel, where balancers are used on a 3-wire system. Centre-zero ammeter and voltmeter for each side of system. Switches, starting gear, and cut-outs for balancer, and shunt regulator. (vi) Station lighting panel. (vii) Battery panel with charge and discharge regulator switches and centre-zero ammeter, showing charge or discharge current; automatic cut-in and cut-out.

(b) For A. C. synchronising panel: power factor indicator. If high tension, oil switches and instrument transformers.

(c) For tramways, 'Board of Trade panel'; also equalising bars, and switches at generators.

(d) Recording (chart) voltmeters may be required.

(e) The type of switches, instruments, etc., and material of panel and framing may be specified or left to each tenderer.

(f) Special distant control and autmatic regulators may be required also special protective gear for excess pressure on A. C. lines.

Accessories :—Connecting cables to generators, balancers, regulating pillars, line, etc.; lightning arrestors and choking coils ; isolating switches, which can be opened up on both sides of any H. T. apparatus when the circuit is broken for repairs ; oil for oil switches ; clock.

Cables.—

(a) Specify whether for feeders or distributors or for trailing cables, or for house wiring, etc.

(b) Whether single, 2 or 3 core, or concentric, and for C. C. or A. C.

(c) Cross-sectional area of each conductor, to be of standard copper.

(d) Working pressure.

(e) Whether any conductor is to be connected to earth.

(f) Class and grade of cable.

(g) Method of laying.

(h) Length of route.

(i) Ascertain actual guaranteed insulation resistance, thickness and nature of dielectric, weight, conductor resistance—at standard temperature.

(j) If for A. C. ascertain capacity, and charging current under working conditions.

(k) Specify who is to lay and joint cable.

Accessories :—Jointing material; distribution boxes, disconnecting links, feeder pillars; troughing, filling and protecting material (if any).

Overhead Lines.—

(a) Whether solid or stranded hard-drawn wire, and S. W. G.

(b) Length of route and of wire required.

(c) Obtain guarantee as to standard conductivity and weight : also ultimate tensile strength.

(d) Specify maximum electrical pressure on insulators and also mechanical stress to be carried.

(e) Ascertain breaking-down conditions of insulators and pins, electrical and mechanical.

(f) State length and construction of brackets or cross arms.

(g) Number of brackets or cross arms and of insulators and pains.

(h) Height above ground and over all length of poles.

(i) Type and ultimate strength of poles.

(j) Special poles, such as towers for long spans, feeder junction poles, heavy terminal or angle poles, etc., to be separately enumerated as in (g) and (h).

(k) Special strain or shackle insulators.

Accessories :—Jointing and binding material; earth wires and earth connections : struts and

stays; anchors for stays; line lightning arrestors, disconnecting links; safety devices and guard wires; spare parts; linesmen's tools.

Steam Plant.—In the case of most of these sub-heads the tenderer should be allowed to specify what he considers most suitable, unless there are reasons to the contrary.

(a) Whether for direct coupling or belt or rope drive.

(b) Brake horse-power—or specify that each set shall be able continuously to drive its generator at the specified overload.

(c) Vertical or horizontal.

(d) Revolutions per minute, according to nature of drive.

(e) Maximum momentary and permanent variation in speed when running on governor and load is thrown on or off.

(f) Whether simple, compound, or triple expansion, or steam turbine.

(g) Condensing or non-condensing.

(h) Open or enclosed and method of lubrication.

(i) Number of cranks.

(j) Steam pressure of stop valve.

(k) Steam consumption and mechanical efficiency

at full, $\frac{1}{2}$, and $\frac{1}{4}$ load and on specified overload of generator.

(l) In case of combined plant, overall efficiency of sets.

Accessories :—Steam and exhaust piping and covering for same ; main valve ; steam traps, drain cocks, relief valves, gauges, tachometer ; condenser, air and circulating pumps, etc.; spare parts ; tools.

Boilers.—

(a) Type—Lancashire, water-tube, marine, loco, etc.

(b) Working pressure and whether superheat required or not.

(c) Fuel to be used and approximate average calorific value.

(d) Nature of draught—natural, forced, or induced.

(e) Steam required per hour—or it may be specified that the boilers shall be capable of steaming continuously at the rate required to obtain the maximum overload of the generating sets.

(f) Whether mechanical stokers are required.

(g) The square feet of grate area, fuel consumption, and actual steaming capacity with given feed temperature.

(h) All certificates required by boiler act to be supplied.

Accessories:—Safety valves; main stop valve; feed check and stop valves; blow off valve; pressure gauge and guards; feed pump or injector; feed water heater; economiser; oil extractor; superheater; steel or other chimney stack; fan for mechanical draught; motors for automatic stoker; economiser, scraper, fan, etc.; firing tools; spare fire bars and gauge glasses; pipe work and valves for main steam range and all above accessories and lagging for boilers and pipes: exhaust piping to condenser or atmosphere or to both.

Oil and Gas Plant.—

See Steam Plant above, (a) to (e) being applicable here also. If the Diesel or semi-Diesel type is required, in preference to the ordinary oil engine, this should be made clear.

(f) State altitude and maximum temperature of place where engine is to be used.

(g) State nature of fuel and average calorific value.

(h) Specify (or inquire) fuel consumption and efficiency at full, $\frac{1}{2}$, and $\frac{1}{4}$ load and at specified overload.

(i) Cooling water tanks and all piping for water and exhaust.

(j) Fuel tanks for oil; producer and accessories for gas.

(k) C.I. sliencer is expensive. A hole in the ground will do.

(l) Starting gear when required; compressed air cylinder for Diesel type.

Steam Turbine should cover the following items :— (a) Number of units and location ; character of building. (b) Service, attachment to driven apparatus (direct, flexible coupling, reduction gear, etc.) (c) Speed, steam and back pressure conditions. (d) Capacity, overload, electric system data. (e) Regulation, variation of speed under change of load. (f) Noise, vibration. (g) Tests and inspection. (h) Mechanical details of connection of driven apparatus. (i) Type and system. H.P., bleeder mixed pressure, giving quantities for L.P., or bleeding steam. (j) Materials—casing, wheels, nozzles, blades, shaft. (k) Piping connections. (l) Bearings (m) Foundations. (n) Oiling. (o) Auxiliary apparatus—oil pumps, relays, step-bearing pumps (for vertical turbines). (p) Painting and lagging. (q) Gauges and miscellaneous equipment, " Standard Hand Book for Electrical Engineers " by Frank F. Fowle.

*** Data necessary in purchasing water wheel.** The following data should be furnished to manufacturers to aid in the economical design of water wheels:—

1. Number of units.
2. Horse power of water wheels.
3. K.w. of generator.
4. Net and gross head, quantity of water available.

5. Open flume or closed flume.
6. If closed flume, what is the number of pipes ?
7. What kind of pipe ?—wooden stave, steel or concrete ?
8. Diameter of pipes.
9. Effective head (unless design of all-water passages to and from wheel is left to water wheel manufacturer).
10. Head water elevation.
11. Floor elevation
12. Tail water elevation.
13. Head variable, if so, what is normal operating head ?
14. If head is variable, what is the range of variation ?
15. Relative importance of power and economy at lowest head.
16. Speed of generator, if already decided.
17. If speed of generator is not decided, name speeds which seem to purchaser most desirable and ask recommendation. Name periodicity of A. C. system.
18. Fly wheel effect of generator.
19. What speed regulation is desired for different load changes ?
20. Will units run in paralled with other plants ? If so, give general characteristics of such plants.

21. If running in parallel with other plants, can these plants be used to regulate the system ?
22. What is the character of load factor ?
23. What is the nature of water (silty or clear)?
24. What date shipment of material is desired.
25. Advise if it is expected that manufacturer shall furnish governor.
26. Give sketches of power plant site.
27. Give information as to what is to be expected in the way of guarantees.
28. Impulse or reaction wheels.
29. Method of regulating inlet ; in case of high heads whether by spear, deflector, or deflecting nozzle.
30. Give any other information which you think would influence the design of the wheel.

Accessories :—Pressure gauge : tachometer : taper pipes from main pipe to nozzle ; main valve : relief valve : governor and connections, spare parts.

*** The following data should be supplied to the purchaser by the manufacturer:—**

1. A check of the calculation on effective head.
2. Horse power guarantee at normal head.
3. Guarantee at other heads, if head is variable.
4. Speed guarantee, including runaway speed.
5. Recommendation for best speed if same has not been determined.

6. Speed regulation guarantees.
7. Water consumption and Efficiency guarantees at full-load, 3/4- load 1/2-load and overload.
8. Point of greatest efficiency of wheel and value of same in per cent.
9. Efficiency guarantees for avilable head conditions.
10. If water wheel manufacturer furnishes governor, give information as to the type, make, power required to operate same, also what variation in speed will not be exceeded before the governor will begin to re-adjust gates to meet a change of load, either gradual or sudden.
11. Complete drawings showing machinery proposed.
12. Complete description of machinery proposed.
13. Guarantee of durability.
14. Guarantee of shipment.

" *Handbook of Mechanical and Electrical Cost Data " by Halbert P. Gillettee and Richard T. Dana.

Pipes.—

(a) Whether each wheel will have its own pipe or whether a common pipe will be used, with a buss pipe.

(b) Length, vertical head, and quantity of water to be carried at full and overload.

(c) Diameter of pipes and loss of head at full and overload—or it may be specified that the pipes

shall carry the quantity of water required, under the net head, for the specified performance of the plant.

(d) Whether single or double riveted, welded, or solid drawn, and thickness and factor of safety ; or latter may be given and details left to the makers.

(e) Nature of joints.

(f) Details as to dipping for protection against corrosion.

Accessories :—Bends, vertical and horizontal, from exact survey of pipe line : expansion joints ; thrust blocks, bell mouths ; valves : air chambers, if necessary, strainers ; jointing material ; spares ; tools.

Appendix to Chapter XXI.

A. It will be many years before the young engineer aquires enough experience to foresee all of the many ways in which a plant may be deficient. If it falls to his lot early in his professional life to call for tenders for any engineering work he will probably find it best to concentrate his attention on what the plant must do rather than on what it is. This he should specify with extreme care, and then call for proposals from every firm of repute he knows of, leaving to them the detail specifications of actual construction. When all tenders are in he should compare them carefully, when he will find that one specification points out

omissions in another (by implication). These omissions he may now point out to those tenderers whose proposals impress him favourably, and ask them to submit ammended quotations.

By this strategy he will force competing firms to lend him experience which is in all probability much greater than that of most superintending engineers

He must remember, however, that it is not playing the game to reveal in his second inquiry the sources of his suggested amendments or the prices quoted by other firms. It is dishonest also to adopt this method of aquiring information if he has no intention of placing an order when he has ascertained where he can get the best value for his expenditure.

B. Note :—That if the contractors or the promoting company (being the manufacturing company or their agent) are entrusted with the design or the running of the plant, there is none to examine or scrutinize their adherence to the standard specification or "test on completion" etc. and thus there is no check on their work. The serious consequences of this require no comment.

CHAPTER XXII.

Laws Affecting the Engineer.

"No man ever lost himself on a straight road"

(Akbar the Great.)

We commend this saying of the great emperor to those students (probably not a few) who will be appalled at the telescopic complications of this chapter. These laws and regulations are for the most part a kind of hedge intented to keep within reasonable limits those wayward members of the human family who prefer the crooked road to the straight one. It is a principle of the law that "Ignorance of the law is no excuse for breaking it", and this may at first sight seem rather unjust, but it should be remembered that the object of all law is to secure a fair division of as much liberty as is possible to gregarious mankind. There are two kinds of men who are likely to infringe the law. They are the unrighteous and selfish man and the stupid and inconsiderate man. Those who do not come under these classifications will find that nearly all law is merely a codification of their own natural instincts. They are not likely to infringe the law if in every dilemma they do what they instinctively know to be right.

Human society is so complex, and the ways in which a crookedly inclined man or a stupid man may wander from the straight path are so numerous that

the system of laws required to keep them from doing so has absorbed the attention of some of the best brains of civilisation for many generations. We have said that the other aspect of the law is that it endeavours to make a fair division of liberty. To take an extreme case, the reason the law prohibits me from abolishing a person I dislike with an axe, is that would be a restriction of that person's right to live. I have to surrender a certain amount of my liberty to him in order to make a fair division. So does he. Very likely he thinks the world would be a better place without me.

The Indian Companies Act.

Is principally concerned with providing that when the public is invited to subscribe to a new company it shall have a reasonable prospect of receiving value for its money.

The Contracts Act.

When any two men make some sort of a 'bundobust,' both of them should understand it thoroughly, and both of them should stick to it. Both of them should be willing, and the 'bundobust' should not be one to interfere with the liberty of a third person.

The Factory Act. Is a sesquipedalian hookum that you must treat your workman with reasonable humanity and take reasonable precautions for their safety from accidents.

The Boiler Act. You are not allowed to blow your workman through the roof just because you are too

stingy to pay for a decent boiler or to keep it in proper order.

The Workman's Compensation Act. If a workman in your employ gets injured or killed in the course of his work you will have to pay compensation whether it is your fault or not. If you are a man in a small way of business you had better insure against the risk of having to do so.

The Maxims of Equity :—You must not take undue advantage of a. y one because he is in difficulty. The bare maxims of equity have been stated for the guidance of the general course of conduct of the Engineer and the manager. A fair knowledge of these maxims will avoid much troubles and litigation.

The reader may now read the follwing exerpts. They are elaborations of the above intended to remove all excuse for misunderstanding the idea.

The Indian Companies Act.

"A private company" means a company which

(i) by its articles—

(a) restricts the right to transfer its shares : and

(b) limits the number of its members (exclusive of persons who are in the employ of the company) to fifty : and

(c) prohibits any invitation to the public to subscribe for any shares or debentures of the company ; and

(ii) continues to observe such restrictions, limitation, and prohibitions :

Provided that, where two or more persons hold one or more shares in a company jointly, they shall, for the purposes of this defination, be considered as a single member :

A private company is distinguished from a public company by the simple expedient of introducing appropriate exceptions into the Act.

Advantages of a private company.

The advantages of a private company, which may not be at first apparent, may be briefly summarised as follows :—

The principal advantage is that of the limited liability of its members. "Ordinary partnerships are by the law assumed and presumed to be based on the mutual trust and confidence of each partner in the skill, knowledge, and integrity of every other partner. As between the partners and the outside world (whatever may be their private arrangements between themselves), each partner is the unlimited agent or every other in every matter connected with the partnership business, or which he represents as partnership business, and not being in its nature beyond the scope of the partnersip. A partner who may not have a farthing of capital left may take moneys or assets of the partnership to the value of millions, may bind the partnership by contract to any amount, may give the partnership acceptances for any amount, and may even—as has been shown in many painful instances in this Court—involve his innocent

partners in unlimited amounts for frauds which he has craftily concealed from them." (Per James L. J. in Baird's case, 5ch. 725, 733).

Registration.

(1) The company, association or partnership formed for business of banking and consisting of more than 10 persons, or

(2) for the purpose of carrying on any other business that has for its objects the acquisition of gain by the company consisting of more than 20 persons shall be duly REGISTERED.

Memorandum of Association.

The memorandum of association of a company is its CHARTER and defines the limitation of the powers of a company established under the Act. Its purpose is two-fold. The first is that the intending corporator who contemplates the investment of his capital shall know within what field it is to be put at risk. The second is that any one who shall deal with the company shall know without reasonable doubt whether the contractual relation into which he contemplates entering with the company is one relating to a matter within its corporate objects.

All persons dealing with a company are deemed to have knowledge of the contents of its memorandum and articles of association, and if a director enters into transactions beyond the scope of the company

or beyond his authority as therein defined, the company will not be liable.

Mode of Forming Incorporated Company.

Any seven or more person (or, where the company to be formed will be a private company, any two or more persons)associated for any lawful purpose may, by subscribing their names to a memorandum of association and otherwise complying with the requirements of this. Act in respect of registration, form an incorporated company, with or without limited liability (that is to say), either—

(i) a company having the liability of its member limited by the memorandum to the amount, if any, unpaid on the shares respectively held by them (in this Act termed a company limited by shares); or

(ii) a company having the liability of its members limited by the memorandum to such amount as the members may respectively thereby undertake to contribute to the assets of the company in the event of its being wound up (in this Act termed a company limited by guarantee) ; or

(iii) a company not having any limit on the liability of its members (in this Act termed an unlimited company).

Memorandum of company limited by shares.

In the case of a company limited by shares—

(1) the memorandum shall state—

(i) the name of the company, with "Limited" as the last word in its name ;

(ii) the province in which the registered office of the company is to be situate ;

(iii) the objects of the company ;

(iv) that the liability of the members is limited ;

(v) the amount of share capital with which the company proposes to be registered, and the division thereof into shares of a fixed amount ;

(2) no subscriber of the memorandum shall take less than one share ;

(3) each subscriber shall write opposite to his name the number of shares he takes.

Memorandum of company limited by guarantee.— in the case of a company limited by guarantee.—

(1) the memorandum shall state—

(i) the name of the company, with "Limited" as the last word in its name ;

(ii) the province in which the registered office of the company is to be situate :

(iii) the objects of the company ;

(iv) that the liability of the members is limited ;

(v) that each member undertakes to contribute to the assets of the company in the event of its being wound up while he is a member , or within one year afterwards,

for payment of the debts and liabilities of the company contracted before he ceases to be a member, and of the costs, charges and expenses of winding up, and for adjustment of the rights of the contributories among themselves, such amount as may be required, not exceeding a specified amount.

(2) if the company has a share capital—

(i) the memorandum shall also state the amount of share capital with which the company proposes to be registered and the division thereof into shares of a fixed amount ;

(ii) no subscriber of the memorandum shall take less than one share ;

(iii) each subscriber shall write opposite to his name the number of shares he takes.

Memorandum of Unlimited Company.

In the case of an unlimited company—

(1) the memorandum shall state—

(i) the name of the company ;

(ii) the province in which the registered office of the company is to be situate :

(iii) the objects of the company :

(2) if the company has a share capital—

(i) no subscriber of the memorandum shall take less than one share ;

(ii) each subscriber shall write opposite to his name the number of shares he takes.

Signature of memorandum.

The memorandum shall be signed by each subscriber in the presence of at least one witness who shall attest the signature.

The witness must be 'some person who stands by but is not a party to the transaction."

Articles of Association are the regulations of the company and are binding until altered in the manner prescribed by the Act. Such articles should be registered.

Form and signature of articles :—

Articles shall—

(a) be printed;

(b) be divided into paragraphs numbered consecutively; and

(c) be signed by each subscriber of the memorandum of association in the presence of at least one witness who must attest the signature.

Alteration of articles by special resolution :—

(1) Subject to the provisions of this Act and to the conditions contained in it special resolution to alter or add to its articles may be made; and any alteration or addition so made shall be as valid as if originally contained in the articles, and be subject in like manner to alteration by special resolution.

(2) A company cannot contract itself out of its statutory right to alter its articles, even by an agreement independent of and outside the articles of association.

Nor can it by the introduction into its articles of clauses to that effect, deprive itself of such statutory right. A company will be restrained by injunction from altering its articles for the purpose of committing a breach of contract.

Effect of memorandum and articles :—

(1) The memorandum and articles shall, when registered, bind the company and the members thereof to the same extent as if they respectively had been signed by each member and contained a covenant on the part of each member, his heirs, and legal representatives to observe all the provisions of the memorandum and of the articles, subject to the provisions of this Act.

(2) All money payable by any member to the company under the memorandum or articles shall be a debt due from him to the company.

The articles constitute a contract between each member and the company, and they bind the company and the shareholders as much as if they had put their seals to them. It has been judicially stated that they also constitute a contract between each individual shareholder and every other, but Lord Herschell laid it down "that there is no contract in terms between the individual members of the company: but the articles do none the less, in my opinion, regulate their rights *inter se*."

The article do not bind the company in relation to any person not a member, though they do in relation to

a shareholder, i. e., member, where the rights of the member are conferred by the articles.

The House of Lords decided in the case of a Life Assurance Company that the company could alter its by-laws and alter its practice in the distribution of profits, and thereby vary its contract with a policyholder.

The company shall keep proper books of account and prepare an authenticated balance sheet at intervals of not more than 15 months.

The following sections of the Act are to be noted:—

(1) Qualification of Director Sec. 73.
(2) Validity of Acts of Director Sec. 74.
(3) Filing of prospectus Sec. 80.
(4) Specific requirements as to particulars of prospectus Sec. 81.
(5) Obligation of companies where no prospectus is issued Sec. 82.
(6) Liability for statement in prospectus Sec. 84.
(7) Restrictions as to allotment Sec. 85.
(8) Effect of irregular allotment Sec. 86.
(9) Restrictions on commencement of business Sec. 87.
(10) Powers and duties of Auditors Sec. 113.
(11) Conversion of private Company into public Company.

The Indian Contract Act.

Contract Act :—Cantracts are arrangements enforcable by law. THE MEANING OF SUCH AGREEMENTS MUST BE CERTAIN.

The essentials of a contract according to the Indian Contract Act are:—

(1) Two or more parties.

(2) A two sided act by which they express their agreement.

(3) The agreement must be made by the free consent of the parties (Secs. 13-22). Thus there must not be coercion which is physical, undue influence which is moral, bodily infirmity or mental distress, or fraud involving (a) a false suggestion, (b) active concealment of facts, (c) a promise made without any intention of performing it, (d) some other act fitted to deceive, (e) some act or omission specially declared by the law to be fraudulent misrepresentation.

(4) The parties must be competent to contract (sec. 11-12). The parties have (i) the age of majority, (ii) soundness of mind, (iii) not been disqualified by law.

(5) The consideration for the agreement must be lawful (Secs. 23-25). It is lawful when it is not (i) forbidden by law, or (ii) of such a nature as to defeat the provisions of any law, or (iii) is fraudulent, or (iv) involves or implies injury to the person or property of another, or (v) regarded by the Court as immoral or opposed to public policy.

(6) The object of the agreement must be lawful (sec. 23).

(7) It must not fall within the class of agreements expressly declared to be void (Secs. 26-30). Such as are (1) Immoral or opposed to Public Policy : (2) Agreements without consideration excepting (a). those made between near relations, (b) when the agreement is to compensate a person who has already done something voluntarily for the person making the promise or something which the person making the promise was legally compellable to do, (c) when the agreement is to pay a debt barred by limiation but otherwise enforceable by law and is made in writing and signed by the party to be charged or his agent.

(8) It must not contravene any law in force in British India, by which any contract is required to be made in writing, or in the presence of witness, or any law relating to registration (Sec. 10).

Contracts in restraint of trade are discountenanced by law. The exceptions are in the case of (i) the Good-will of a business, (ii) partners in anticipation of a dissolution of partnership may agree that some or all of them will not carry on a business similar to the partnership business with certain local limits and they may agree that during the continuance of the partnership they will not carry on any other business than that of the partnership.

The law allows certain contingent contracts such as contracts of indemnity or of insurance although agreements by way of wager are generally void.

The mode of performance of contract :—

The parties to a contract must perform or offer to perform their respective promises in such a way as the law considers tantamount to performance. The offer of performance must be :—

(i) unconditional.

(ii) made at a proper time and place and under such circumstances as to allow the other party a reasonable opportunity of ascertaining that the person offering to perform is able to perform the whole of that which he has promised.

(iii) when the offer is to deliver something the promisee must have a reasonable opportunity of seeing that the thing offered is the same-thing as that which the promiser is bound to deliver.

By a complete SALE is meant a transfer of the ownership of a thing from a seller to the buyer in exchange for a price.

BY OWNERSHIP is meant the right by virtue of which a man excercises complete and exclusive dominion over a thing. It does not necessarily connote the right to immediate unconditional possession. A person is said to be the owner of a thing, though he is not in actual enjoyment of any of the rights of ownership, if, upon the performance of some conditions he is entitled

to be invested with those rights and can transfer that title to another.

A SALE is complete when anyone of the following conditions has been complied with :—

(1) Earnest, or tender, payment or part payment of the price, or

(2) Delivery or part delivery of the thing, or

(3) An agreement, expressed or implied for the postponment of the delivery or of payment or of both.

The occurrence of any one of these circumstances coupled with offer and acceptance of the price for the thing or the thing for the price render the sale complete, and the ownership has passed. DELIVERY of a thing is effected by any act which has the effect of transferring the possession from one person to another.

The seller has got two rights :—(1) that of lieu, (2) that of stoppage in transit to protect him against the insolvency or fraudulent acts of the buyer.

The buyer obtains no better title to the goods than his seller had to convey excepting in the following cases :—

(1) In commercial dealings a bonafide purchaser is conveyed a good title by anyone who with the consent of the owner has in his possession goods or decuments showing a title to goods.

(2) A bonafide purchaser who sees his seller in possession and has no reason to suppose that he is not entitled to sell. This has reference to the case of one

of several joint owners having by provision of the co-owners the possession of goods.

(3) A **bonafide sub-purchaser** of goods from one who is in possession of goods under a contract voidable at the option of the vendor.

Warranty :—There are (a) warranty of title, (b) warranty of quality and (c) implied warranty

(a) WARRANTY OF TITLE :—If the buyer, or any person claiming under him, is, by reason of the invalidity of the seller's title, deprived of the thing sold the seller is responsible to the buyer, or the person claiming under him, for loss caused thereby, unless a contrary intention appears by the contract.

(b) WARRANTY OF QUALITY :—An implied warranty of goodness or quality may be established by the custom of any particular trade.

(c) IMPLIED WARRANTY:—(1) Of soundness on Sale of provisions, (2) of bulk on sale of goods by sample, (3) when goods are sold of a certain denomination, (4) when ordered for a specified purpose.

Law of Agency :—An 'agent' is a person employed to do any act for another, or to represent another, in dealings with third persons. The person for whom the act is done, or who is so represented, is called the 'PRINCIPAL'.

The responsibility for the acts of third person :—May arise from (1) previous authorization, or (2) from subsequent adoption of the service in respect of

which the liability is sought to be enforced. The authority may be in express terms or it may arise by presumption based on the general course of conduct on the nature of the circumstances or on the relations existing between the persons concerned.

Extent of Agent's Authority :—His authority to be of a particular service extends to all things necessary for its performance and his authority to carry on a business has authority to do every lawful thing necessary for the purpose or usually done in the course of conducting such business. He should act in emergency as a man of ordinary prudence would act under similar circumstances supposing that his own personal interests were at stake.

Revocation or Termination of Authority.

Termination of Agency :—An agency is terminated by the principal revoking his authority; or by the agent renouncing the business of the agency; or by the business of the agency being complete; or by either the principal or agent dying or becoming of unsound mind; or by the principal being adjudicated an insolvent under the provisions of any Act for the time being in force for the relief of insolvent debtors.

Termination of agency, where agent has an interest in the subject-matter :—Where the agent has himself an interest in the property which forms the subject-matter of the agency, the agency cannot, in the absence of an express contract, be terminated to the prejudice of such interest.

Duty of Agent to Principal :—(1) To act according to the directions of the principal or the local custom of the business ; he must conduct the business with the proper skill and seek to obtain instructions ; show in different cases reasonable diligence unless the principal has notice of his want of skill. He should make compensation to his principal in respect of direct consequence of his own neglect, want of skill or misconduct but not in respect of loss or damage which are indirectly or remotely caused by such neglect, want of skill or misconduct. He is bound to render proper accounts to his principal on demand.

A 'sub-agent' is a person employed by, and acting under the control of the original agent in the business of the agency.

Representation of Principal by sub-agent Properly appointed :—Where a sub-agent is properly appointed, the principal is, so far as regards third persons, represented by the sub-agent, and is bound by and responsible for his acts, as if he was an agent originally appointed by the principal.

Agent's responsibility for sub-agent :—The agent is responsible to the principal for the acts of the sub agent.

Sub-agent's responsibility :—The sub-agent is responsible for his acts to the agent, but not to the principal, except in cases of fraud or wilful wrong.

When agent cannot delegate:—An agent cannot lawfully employ another to perform acts which he has

expressly or impliedly undertaken to perform personally, unless by the ordinary custom of trade a sub-agent may, or, from the nature of the agency, a sub-agent must, be employed.

Agent's responsibility for sub-agent appointed without authority. Where an agent, without having authority to do so, has appointed a person to act as a sub-agent, the agent stands towards such person in the relation of a principal and is responsible for his acts both to the principal and the third person: the principal is not represented by or responsible for the person so employed, nor is that person responsible to the principal.

Principal's right to benefit gained by agent dealing on his own account in business of agency. If an agent, without the knowledge of his principal, deals in the business of the agency on his own account instead of on account of his principal, the principal is entitled to claim from the agent any benefit which may have resulted to him from the transaction.

Agent's right of retainer out of sums received on principal's account. An agent may retain, out of any sums received on account of the principal in the business of the agency, all moneys due to himself in respect of advances made or expenses properly incurred by him in conducting such business, and also such remuneration as may be payable to him for acting as agent.

Agent to be indemnified against consequences of lawful acts. The employer of an agent is bound to indemnify him against the consequences of all lawful acts done by such agent in exercise of the authority conferred upon him.

Agent to be indemnified against consequences of acts done in good faith.—Where one person employs another to do an act, and the agent does the act in good faith, the employer is liable to indemnify the agent against the consequences of that act, though it causes an injury to the rights of third presons.

Non-liability of employer of agent to do a criminal act.—Where one person employs another, to do an act which is criminal, the employer is not liable to the agent, either upon an express or an implied promise to indemnify him against the consequences of that act.

Compensation to Agent for injury caused by principal's neglect.—The principal must make compensation to his agent in respect of injury caused to such agent by the principal's neglect or want of skill.

Enforcement and consequences of Agent's contracts.—Contracts entered into through an agent, and obligation arising from acts done by an agent, may be enforced in the same manner, and will have the same legal consequences, as if contracts had been entered into and the acts done by the principal in person.

Principal how far bound when agent exceeds authority.—When an agent does more than he is

authorized to do, and when the part of what he does, which is within his authority, can be separated from the part which is beyond his authority, so much only of what he does as is whithin his authority is binding as between him and his principal.

Principal not bound when excess of agent's authority is not separable.—Where an agent has done more than he is authorized to do, and what he does beyond the scope of his authority cannot be separated from what is within it, the principal is not bound to recognize the transaction.

Agent cannot personally enforce, nor be bound by, contracts on behalf of principal.—In the absence of any contract to that effect, an agent cannot personally enforce contracts entered into by him on behalf of his principal, nor is he personally bound by them.

Presumption of contract to contrary.—Such a contract shall be presumed to exist in the following cases:—

(1) Where the contract is made by an agent for the sale or purchase of goods for a merchant resident abroad.

(2) Where the agent does not disclose the name of his principal.

(3) Where the principal, though disclosed, cannot be sued as out of jurisdiction.

(4) When agent personally binds himself by the contract entered into by him so far (a) as the principal, (b) as the other party to the contract are concerned.

Rights of person dealing with agent personally liable.—In cases where the agent is personaliy liable, a person dealing with him may hold either him or his principal, or both of them, liable.

Effect on agreement, of misrepesentation or fraud by agent —Misrepresentations made, or frauds committed, by agents acting in the course of their business for their principals have the same effect on agreements made by such agents as if such misrepresen tations or frauds had been made or committed by the principals : but misrepresentations made, or fraud committed, by agents, in matters which do not fall within their authority, do not affect their principals.

Partnership.

"**Partnership**" is the relation which subsists between persons who have agreed to combine their property, labour, or skill in some business, and to share the profits thereof between them.

Responsibility of person leading another to believe him a partner:—A person who has, by words spoken or written, or by his conduct, led another to believe that he is a partner in a particular firm, is responsible to him as a partner in such firm.

Liability of person on permitting himself to be represented as a partner Any one consenting to allow himself to be represented as a partner, is liable, as such to third persons who, on the faith thereof, gives credit to the partnership.

Partner's liability for debts of partnership. Every partner is liable for all debts and obligations incurred while he is a partner in the usual course of business by or on behalf of the partnership; but a person who is admitted as a partner into an existing firm does not thereby become liable to the creditors of such firm for anything done before he became a partner.

Partners liability to third person for neglect or fraud of co-partner. Every partner is liable to make compansation to third persons in respect of loss or damage arising from the neglect or fraud of any partner in the management of the business of the firm.

Partner's power to bind co-partners :—Each partner who does any act necessary for, or usually done in carrying on the business of such a partnership as that of which he is a member, binds his co-partners to the same extent as if he were their agent duly appointed for that purpose.

Rules determining partners' mutual relations. where no contract to contrary.—In the absence of any contract to the contrary, the relations of partners to each other are determined by the following rules :—

(1) all partners are joint-owners of all property originally brought into the partnership stock, or brought with money belonging to the partnership, or acquired for purposes of the partnership business. All such property is called partnership property. The share of each

partner in the partnership property is the value of his original contribution, increased or diminished by his share of profit or loss :

(2) all partners are entitled to share equally in the profits of the partnership business, and must contribute equally towards the losses sustained by the partnership :

(3) each partner has a right to take part in the management of the partnership business :

(4) each partner is bound to attened diligently to the business of the partnership, and is not entitled to any remuneration for acting in such business :

(5) when differences arise as to ordinary matters connected with the partnership business, the decision shall be according to the opinion of the majority of the partners ; but no change in the nature of the business of the partnership can be made except with the consent of all the partners:

(6) no person can introduce a new partner into a firm without the consent of all the partners :

(7) if, from any cause whatsoever, any member of a partnership ceases to be so, the partnership is dissolved as between all the other members :

(8) unless the partnership has been entered into for a fixed term, any partner may retire from it at any time :

(9) where a partnership has been entered into for a fixed term, no partner can, during such term, retire, except with the consent of all the partners, nor can he be expelled by his partners for any cause whatever, except by order of Court :

(10) partnerships, whether entered into for a fixed term or not, are dissolved by the death of any partner.

When Court may dissolve partnership. At the suit of a partner Court may dissolve the partnership in the following cases :

(1) when a partner becomes of unsound mind.

(2) when a partner, other than the partner suing, has been adjudicated an insolvent under any law relating to insolvent debtors :

(3) when a partner, other than the partner suing, has done any act by which the whole interest of such partner is legally transferred to a third person :

(4) when any partner becomes incapable of performing his part of the partnership contract :

(5) when a partner, other than the partner suing, is guilty of gross misconduct in the affairs of the partnership or towards his partners :

(6) when the business of the partnership can only be carried on at a loss.

General duties of partners.—Partners are bound to carry on the business of the partner-ship for the greatest common advantage, to be just and faithful to each other, and to render true accounts and full information of all things affecting the partnership to any partner or his legal representatives.

The Indian Factories Act, XXII of 1911. Modified up to 1st July, 1922

The following provisions of the Act are to be specially noted by all managers of a factory :—

Note that **a factory is** :—

(a) "any premises wherein, or within the precincts of which, on any one day in the year not less than twenty persons are simultaneously employed and steam, water or other mechanical power or electrical power is used in aid of any process for, or incidental to making altering, repairing, ornamenting, finishing or otherwise adopting for use for transport or for sale any article or part of an article; or

(b) any premises wherein, or within the precincts of which on any one day in the year not less than ten persons are simultaneously employed and any such process is carried on, whether any such power is used in aid thereof or not which have been declared by the Local Government, by notification in the local official Gazette, to be a factory; "

A declaration under clause (b) may be made in respect of any class of premises, or in respect of any particular premises.

Provisions for Health and Safety.

There must be sufficient arrangements (a) for proper sanitation with special reference to cleanliness,

ventilation, lighting, pure water, latrine and urinal accommodation and drainage and for supply of sufficient suitable water fit for drinking for the employees in the factory.

(b) For precautions against fire and means of escape in case of fire. The doors of each room in which more than 30 persons are employed, shall except in the case of sliding door, be so constructed as to open outwards. (c) For necessary and efficient fencing round any machine or part.

(d) For prohibiting any person to smoke, or use a naked light or cause or permit any such light to be used in the immediate vicinity of any inflamable material in any factory.

(e) To keep the buildings of the factory or machinery used therein in good repair to avoid all danger to life and property.

(f) To prohibit the employment of women and children in certain dangerous works, and in certain process if they are under 18 years. Note that a child for working in a factory must be duly certified to be not less than twelve years of age and is under the age of 15 years.

Provisions for Rest Period.

(1) "In every factory there shall be fixed,—

(a) for each person employed on each working day

(i) at intervals not exceeding six hours, periods of rest of not less than one hour, or

(ii) at the request of the employees concerned, periods of rest of not less than half an hour each so arranged that, for each period of six hours work done, there shall be periods of rest of not less than one hour's duration in all, and that no person shall work for more than five hours continuously, and

(b) for each child working more than five and a half hours in any day, a period of rest of not less than half an hour.

(2) The period of rest under clause (b) shall be so fixed that no such child shall be required to work continuously for more than four hours."

Weekly Holidays.

(1) No person shall be employed in any factory on a Sunday or, on one of the three days immediately preceding or succeeding the Sunday, provided that by such substitution no person has to work for 10 consecutive days.

In order to enable the Inspector to see that the provisions of the Act for a weekly holiday are observed, the manager of every factory shall keep a daily register of attendance, separately by departments if he so desires of all persons including children employed in special forms showing the dates, whether Sundays or week

days, on which the factory or any department thereof is closed and its employees are not working. It shall also show the hours of work on each day of all the persons working in the factory. The time of commencing work, rest period, the time of ending work, the days of absence and the nature of the respective employment of each person shall also be stated therein. Opposite the name of each child shall be entered his or her serial number as entered in the register for children. The register shall be posted within four hours of the starting time of the factory for each working period.

If a manager prefers, he may maintain the register in two parts, one for each half of the month. When this is done, particulars of father's name and caste need be entered only in the part which relates to the first half of the month.

Provisions For Hours Of Employment.

(1) No child or women shall be employed in any factory before halfpast five A. M. or after seven P. M.

(2) The maximum number of working hours in any one day for a child is six hours and for any person 11 hours, and the maximum number of working hours in any one week is 60 hours.

Exemptions :—The above provisions are subject to certain exceptions depending on (a) class of work preparatory or complementory to some other work. The rate of payment for overtime work shall

be at least one and a quarter times the rate at which he is normally paid.

(b) Nature of the work being intermittent or otherwise.

(c) Work requiring continuous production for technical reasons.

(d) The factory supplying articles of prime necessity which must be made or supplied every day.

(e) That in any class of factories the work performed, by the exigencies of the trade or by its nature, cannot be carried on except at stated seasons or at times dependent on the irregular action of natural forces.

(f) Exceptions sanctioned by the Local Govenment in case of (1) exceptional press of work, (2) works of urgent repairs and in certain cases for Indigo, Tea or Coffee Factories.

The total overtime permitted for women shall not exceed six hours during the week and for men the overtime shall not be such as to make the hours of work exceed twelve on any one day.

Provision for Notices and Registers.

The Inspector should be informed of :—(1) every change of manager by the occupier within seven days from the date on which the change is made.

(2) every accident causing death or bodily injury disabling the person from attending his work within 48 hours of the occurance of the accident.

"In every factory there shall be kept, in the prescribed form, a register of all the persons employed in such factory, of their hours of work and of the nature of their respective employment.

(1) There shall be affixed in some conspicuous place near the main entrance of every factory, in English and in the language of the majority of the operatives in such factory, the prescribed abstracts of this Act and of the rules made thereunder, and also a notice containing the standing orders of the factory upon the following matters, namely :—

(a) The time of beginning and ending work on each day ;

(b) The periods of rest fixed under section 21.

(c) The hours of beginning and ending work for each shift (if any): and

(d) The hours of employment of (all persons employed) ;

(e) The weekly holidays fixed under section 22.

(2) A copy of the said notice shall be sent to the inspector.....within one month of commencing work.

(3) The said notice shall be correctly maintained and kept up to date, and intimation of any change

therein shall be sent by the manager to the inspector within seven day."

Act No. V of 1923.

Of the laws relating to **steam boilers** the following provisions should be noted :—

Definitions :—(1) "BOILER" means any closed vessel exceeding five gallons in capacity which is used expressly for generating steam under pressure for use outside such vessel, and includes any mounting or other fitting attached to such vessel which is wholly or partly under pressure when steam is shut off.

(2) "steam-pipe" means any main pipe exceeding three inches in internal diameter through which steam passes directly from a boiler to a prime-mover or other first user, and includes any connected fitting of a steam-pipe.

Prohibition of use of unregistered or uncertificated boiler :—

No owner of a boiler shall use the boiler or permit it to be used :—

(a) Unless it has been duly registered :

(b) When a boiler has been transferred from one province to another, until the transfer has been reported in the prescribed manner ;

(c) Unless a certificate or provisional order authorising the use of the boiler is for the time being in force under this Act ;

(d) At a preasure higher than the maximum pressure recorded in such certificate or provisional order ;

(e) Where the Local Government has made rules requiring that boilers shall be in charge of persons holding certificates of competency, unless the boiler is in charge of a person holding the certificate required by such rules :

Provided that any boiler registered, or any boiler certified or licensed, under any Act hereby repealed shall be deemed to have been registered or certified, as the case may be, under this Act :

Provided, further, that, until the expiration of twelve months from the commencement of this Act, nothing in this section shall be deemed to prohibit the use of any boiler in any local area in which the registration of, or a certificate or licence for the use of, a boiler was not previously required by law.

(1) The owners of unregistered boilers should apply to the Boiler Inspector accompanied by the prescribed fee.

(2) The inspector shall fix a date for examination of the boiler within thirty days from the date of the receipt of their application and shall give the owner not less than 10 days notice of the date so fixed.

(3) The inspector shall examine the boiler and determine the maximum pressure at which the

boiler may be used and report the result to the Chief Inspector.

(4) The Chief Inspector, on receipt of the report, may—

(a) Register the boiler and assign a register number thereto either forthwith or after satisfying himself that any structural alteration, addition or renewal which he may deem necessary has been made in or to the boiler or any steam-pipe attached thereto, or

(b) Refuse to register the boiler :

Provided that where the Chief Inspector refuses to register a boiler, he shall forthwith communicate his refusal to the owner of the boiler together with the reasons therefor.

(5) The Chief Inspector shall, on registering the boiler, order the issue to the owner of a certificate in the prescribed form authorising the use of the boiler for a period not exceeding twelve months at a pressure not exceeding such maximum pressure as he thinks fit and such order will be conveyed by the Inspector to the owner.

(1) **A certificate authorising the use of a boiler shall cease to be in force.—**

(a) On the expiry of the period for which it was granted ; or

(b) When any accident occurs to the boiler; or

(c) When the boiler is moved, the boiler not being a vertical boiler the heating surface of which is less than two hundred square feet, or a portable or vehicular boiler; or

(d) When any structural alteration, addition or renewal is made in or to the boiler; or

(e) If the Chief Inspector in any particular case so directs, when any structural alteration, addition or renewal is made in or to any steam-pipe attached to the boiler; or

(f) On the communication to the owner of the boiler of an order of the Chief Inspector or Inspector prohibiting its use on the ground that it or any steam-pipe attached thereto is in a dangerous condition.

(2) When a certificate ceases to be in force, the owner of the boiler may apply to the Inspector for a renewal thereof for such period not exceeding twelve months as he may specify in the application accompanied by the prescribed fee.

The **date of examination of the boiler** will be fixed and the **owner notified of the boiler,** the boiler will be examined and if the boiler and steam-pipes are in good condition the certificate shall be renewed.

Provided that if the Inspector—

(a) Proposes to issue any certificate—

(i) Having validity for a less period than the period entered in the application, or

(ii) Increasing or reducing the maximum pressure at which the boiler may be used, or

(b) Proposes to order any structural alteration, addition or renewal to be made in or to the boiler or any steam-pipe attached thereto, or

(c) Is of opinion that the boiler is not fit for use, the Inspector shall, within forty-eight hours of making the examination, inform the owner of the boiler in writing of his opinion and the reasons therefor, and shall forthwith report the case for orders to the Chief Inspector.

The Chief Inspector may renew the certificate in such terms and on such conditions as he thinks fit or may refuse to renew it.

Provisional orders :—The Inspector may grant to the owner thereof a provisional order in writing permitting the boiler to be used except when the boiler or steam-pipe is in a dangerous condition. Such provisional order shall cease to be in force—

(a) on the expiry of six months from the date on which it is granted, or

(b) on receipt of the orders of the Chief Inspector, or

(c) in any of the cases referred to in clauses (b), (c), (d), (e) and (f) of sub-section (1), page 356,

and on so ceasing to be in force shall be surrendered to the Inspector.

Use of boiler pending grant of certificate:—The owner of a boiler may apply for a renewed certificate at any time during the currency of a certificate. In this case the owner is entitled to use the boiler at the maximum pressure entered in the former certificate pending the issue of orders on the application.

Alterations and renewals to boilers:—No structural alteration, addition or renewal shall be made in or to any boiler registered under this Act unless such alteration, addition or renewal has been sanctioned in writing by the Chief Inspector.

Alterations and renewals to steam-pipes. Before the owner of any boiler registered under this Act makes any structural alteration, addition or renewal in or to any steam-pipe attached to the boiler, he shall transmit to the Chief Inspector a report in writing of his intention, and shall send therewith such particulars of the proposed alteration, addition or renewal as may be prescribed.

Duty of owner at examination.

(1) On any date fixed under this Act for the examination of a boiler, the owner thereof shall be bound—

(a) to afford to the Inspector all reasonable facilities for the examination and all such

information as may rensonably be required of him;

(b) to have the boiler properly prepared and ready for examination in the prescribed manner; and

(c) in the case of an application for the registration of a boiler, to provide such drawings, specifications, certificates and other particulars as may be prescribed.

(2) If the owner fails, without reasonable cause, to comply with the provisions of sub-section (3), the Inspector shall refuse to make the examination and shall report the case to the Chief Inspector who shall, unless sufficient cause to the contrary is shown require the owner to file a fresh application under special section as the case may be, and may forbid him to use the boiler.

Production of certificates, etc. :—The owner of a boiler must produce the boiler certificate or provisional order to the proper authority at all reasonable times.

Transfer of certificates, etc. :—If any person becomes the owner of a boiler during the period for which a certificate or provisional order relating thereto is in force, the preceding owner shall be bound to make over to him the certificate or provisional order.

Report of accidents :—(1) If any accident occurs to a boiler or steam-pipe, the owner or person in charge thereof shall, within twenty-four hours of the accident, report the same in writing to the Inspector. Every

such report shall contain a true description of the nature of the accident and of the injury, if any, caused thereby to the boiler or to the steam-pipe or to any person, and shall be in sufficient detail to enable the Inspector to judge of the gravity of the accident.

(2) Every person shall be bound to answer truly to the best of his knowledge and ability every question put to him in writing by the Inspector as to the cause, nature or extent of the accident.

Appeals to Appellate Authority:— An aggrieved person may appeal against the orders of an Inspector to the Chief Inspector. The period of limitation being within 30 days from the date on which such order or refusal is communicated to him, or may lodge with the Chief Inspector an appeal against an original or appellate order of the Chief Inspector to an appellate authority to be constituted by the Local Government under this Act.

Workmen's Compensation Act 1923.

Definitions:—

(a) "Dependant" means any of the following relatives of a deceased workman, namely, a wife, husband, parent, minor son, unmarried daughter, married daughter who is a minor, brother or unmarried sister, and includes the minor children of a deceased son of the workman and, where no parent of the workman is alive a paternal grandparent.

(b) "Employer" includes any body of persons whether incorporated or not and any managing agent

of an employer and the legal representative of a deceased employer, and, when the services of a workman are temporarily lent or let on hire to another person by the person with whom the workman has entered into a contract of service or apprenticeship, means such other person while the workman is working for him. The definition is not exhaustive.

(c) "MANAGING AGENT" means any person appointed or acting as the representative of another person for the purpose of carrying on such other person's trade or business, but does not include an individual manager subordinate to an employer.

(d) "PARTIAL DISABLEMENT" means, where the disablement is of a temporary nature, such disablement as reduces the earning capacity of a workman in any employment in which he was engaged at the time of the accident resulting in the disablement, and, where the disablement is of a permanent nature, such disablement as reduces his earning capacity in every employment which he was capable of undertaking at that time: provided that every injury specified in Schedule I shall be deemed to result in permanent partial disablement.

(e) "TOTAL DISABLEMENT" means such disablement, whether of a temporary or permanent nature, as incapacitates a workman for all work which he was capable of performing at the time of the accident resulting in such disablement: provided that permanent total disablement shall be deemed to result from the

permanent total loss of the sight of both eyes or from any combination of injuries specified in Schedule I where the aggregate percentage of the loss of earning capacity, as specified in that Schedule against those injuries, amounts to one hundred per cent.

(f) "WAGES" includes any privilege or benefit which is capable of being estimated in money, other than a travelling allowance or the value of travelling concession or a contribution paid by the employer of a workman towards any pension or provident fund or a sum paid to a workman to cover any special expenses entailed on him by the nature of his employment.

(g) "WORKMAN" means any person (other than a person whose employment is of a casual nature and who is employed otherwise than for the purposes of the employer's trade or business) who is,—

(i) a railway servant as defined in section 3 of the Indian Railways Act, 1890, not permanently employed in any administrative, district or sub-divisional office of a railway and not employed in any such capacity as is specified in Schedule II, of the Act, 1923, or

(ii) employed, either by way of manual labour or on monthly wages not exceeding three hundred rupees, in any such capacity as is specified in Schedule II of the Act, 1920, whether the contract of employment was made before or after the passing of this Act and whether such contract is expressed or implied, oral or in writing; but does not include any person working in

the capacity of a member of His Majesty's naval, military or air forces or of the Royal Indian Marine Service; and any reference to a workman who has been injured shall, where the workman is dead, include a reference to his dependants or any of them.

Employer's Liability for compensation.—

If a personal injury is caused to a workman by accident arising out of and in the course of his employment his employer shall be liable to pay compensation as described hereunder.

(1) Provided that the employer shall not be so liable —

(a) in respect of any injury which does not result in the total or partial disablement of the workman for a period exceeding ten days :

(b) in respect of any injury to a workman resulting from an accident which is directly attributable to —

(i) the workman having been at the time thereof under the influence of drink or drugs, or

(ii) the wilful disobedience of the workman to an order expressly given, or to a rule expressly framed, for the purpose of securing the safety of workmen, or

(iii) the wilful removal or disregard by the workman of any safety guard or other

device which he knew to have been provided for the purpose of securing the safety of workmen ; or

(iv) except in the case of death or permanent total disablement, in respect of any workman employed in the construction, repair or demolition of a building or bridge.

(2) If a workman employed in any employment involving the handling of wool, hair, bristles, hides, or skins contracts the disease of anthrax, or if a workman whilst in the service of an employer in whose service he has been employed for a continuous period of not less than six months in any emyloyment specified in Schedule III, contracts any disease specified therein as an occupational disease peculiar to that employment, the contracting of the disease shall be deemend to be an injury by accident within the meaning of this section and, unless the employer proves the contrary, the accident shall be deemed to have arisen out of and in the course of the employment.

Explanation — For the purpose of this sub-section a period of service shall be deemed to be continuous which has not included a period of service under any other employer.

(3) The Governor-General in Council, after giving, by notification in the Gazette of India, not less than three months' notice of his intention so to do, may by a like notification, add any description of employment to the employments specified in Schedule III, and shall

specify in the case of the employments so added the diseases which shall be deemed for the purposes of this section to be occupational diseases peculiar to those employments respectively, and the provisions of sub-section (2) shall thereupon apply as if such diseases had been declared by this Act to be occupational diseases peculiar to those employments.

(4) Save as provided by sub-sections (2) and (3), no compensation shall be payable to a workman in respect of any disease unless the disease is solely and directly attributable to a specific injury by accident arising out of and in the course of his employment.

(5) Nothing herein contained shall be deemed to confer any right to compensation on a workman in respect of any injury if he has instituted in a Civil Court a suit for damage in respect of the injury against the employer or any other person and no suit for damages shall be maintainable by a workman in any Court of law in respect of any injury —

(a) if he has instituted a claim to compensation in respect of the injury before a Commissioner ; or

(b) if an agreement has been come to between the workman and his employer providing for the payment of compensation in respect of the injury in accordance with the provisions of this Act.

Amount of compensation. A. WHERE DEATH RESULTS FROM THE INJURY —

(i) in the case of an adult, a sum equal to thirty months' wages or two thousand five hundred rupees, whichever is less, and

(ii) in the case of a minor, two hundred rupees;

(B). WHERE PERMANENT TOTAL DISABLEMENT RESULTS FROM THE INJURY —

(i) in the case of an adult, a sum equal to forty-two months' wages or three thousand five hundred rupees, whichever is less, and

(ii) in the case of a minor, a sum equal to eighty-four months' wages or three thousand five hundred rupees, whichever is less;

(C). WHERE PERMANENT PARTIAL DISABLEMENT RESULTS FROM THE INJURY. —

(i) in the case of an injury specified in Schedule I, such percentage of the compensation which would have been payable in the case of permanent total disablement as is specified therein as being the percentage of the loss of earning capacity caused by that injury, and

(ii) in the case of an injury not specified in Schedule I, such percentage of the compensation payable in the case of permanent total disablement as is proportionate to the loss of earning capacity permanently caused by the injury;

EXPLANATION.—Where more injuries than one are caused by the same accident, the amount of compensation payable under this head shall be aggregated but not

so in any case as to exceed the amount which would have been payable if permanent total disablement had resulted from the injuries.

D. WHERE TEMPORARY DISABLEMENT, WHETHER TOTAL OR PARTIAL RESULTS FROM THE INJURY, a half-monthly payment payable on the sixteenth day after the expiry of a waiting period of ten days from the date of the disablement, and thereafter half-monthly during the disablement or during a period of five years, whichever period is shorter,—

(i) in the case of an adult, of fifteen rupees or a sum equal to one-fourth of his monthly wages, whichever is less, and

(ii) in the case of a minor, of a sum equal to one third or, after he has attained the age of fifteen years, to one-half of his monthly wages, but not exceeding in any case fifteen rupees.

Provided that there shall be deducted from any lump sum or any payment to which the workman is entitled the amount of any payment or allowance which the workman has received from the employer by way of compensation during the period of disablement prior to the receipt of such lump sum or of the first half-monthly payment, as the case may be, and no half-monthly payment shall in any case exceed the amount, if any, by which half the amount of the monthly wages of the workman before the accident exceeds half the amount of such wages he is earning after the accident.

On the ceasing of the disablement before the date on which any half-monthly payment falls due, there shall be payable in respect of that half-month a sum proportionate to the duration of the disablement in that half-month.

Method of calculating wages :—(a) Where the workman has, during a continuous period of not less than twelve months immediately proceeding the accident, been in the service of the employer who is liable to pay compensation, the monthly wages of the workman shall be one-twelfth of the total wages which have fallen due for payment to him by the employer in the last twelve months of that period.

(b) In other cases, the monthly wages shall be thirty times the total wages earned in respect of the last continuous period of service immediately preceding the accident from the employer who is liable to pay compensation, divided by the number of days comprising such period.

Provided that the sum arrived at by a calculation under clause (a) or clause (b) shall be increased or decreased, as the case may be.

EXPLANATION :—A period of service shall, for the purposes of this section, be deemed to be continuous which has not been interrupted by a period of absence from work exceeding fourteen days.

Distribution of compensation :—(1) Compensation payable in respect of a workman whose injury has resulted in death shall be deposited with the Commissioner

and any sum so deposited shall be apportioned among the dependents of the deceased workman or any of them in such proportion as the Commissioner thinks fit, or may, in the discreation of the Commissioner, be allotted to any of one such dependant, and the sum so allotted to any dependant shall be paid to him or, if he is a person under any legal disability, be invested, applied or otherwise dealt with for his benefit during such disability in such manner as the Commissioner thinks fit.

(2) Any other compensation payable under this Act may be deposited with the Commissioner and, when so deposited, shall be paid by the Commissioner to the person entitled thereto.

(3) The receipt of the Commissioner shall be a sufficient discharge in respect of any amount deposited with him under sub-section (1) or sub-section (2).

(4) On the deposit of any money under sub—section (1), the Commissioner may deduct therefrom the actual cost of the workman's funeral expenses, to an amount not exceeding fifty rupees and pay the same to the person by whom such expenses were incurred, and shall, if he thinks necessary, cause notice to be published or to be served on each dependant in such manner as he thinks fit, calling upon the dependants to appear before him on such date as he may fix for determining the distribution of the compensation. If the Commissioner is satisfied, after any inquiry which he may deem necessary, that no dependant exists, he

shall repay the balance of the money to the employer by whom it was paid. The Commissioner shall, on application by the employer, furnish a statement showing in detail all disbursements made.

(5) Where a half-monthly payment is payable under this Act to a person under any legal disability, the Commissioner may, of his own motion or on application made to him in this behalf, order that the half-monthly payment be paid during the disability to any dependant of the workman or to any other person whom he thinks best fitted to provide for the welfare of the workman.

(6) Where, on application made to him in this behalf or otherwise, the Commissioner is satisfied that, on account of neglect of children on the part of a parent or on account of the variation of the circumstances of any dependant or for any other sufficient cause, an order of the Commissioner as to the distribution of any sum paid as compensation or as to the manner in which any sum payable to any such dependant is to be invested, applied or otherwise dealt with, ought to be varied, the Commissioner may make such orders for the variation of the former order as he thinks just in the circumstances of the case:

Provided that no such order prejudicial to any person shall be made unless such person has been given an opportunity of showing cause why the order should not be made, or shall be made in any case in which it

would involve the repayment by a dependent of any sum already paid to him.

Notice and claim :—(1) No proceedings for the recovery of compensation shall be maintainable before a Commissioner unless notice of the accident has been given, in the manner hereinafter provided, as soon as practicable after the happening thereof and before the workman has voluntarily left the employment in which he was injured, and unless the claim for compensation with respect to such accident has been instituted within six months of the occurrence of the accident or, in case of death, within six months from the date of death:

Provided that, where the accident is the contracting of a disease in respect of which the provisions of sub-section (2) of section 3 are applicable, the accident shall be deemed to have occurred on the first of the days during which the workman was continuously absent from work in consequence of the disablement caused by the disease:

Provided, further, that the Commissioner may admit and decide any claim to compensation in any case notwithstanding that the notice has not been given, or the claim has not been instituted, in due time as provided in this sub-section, if he is satisfied that the failure so to give the notice or institute the claim, as the case may be, was due to sufficient cause.

(2) Every such notice shall give the name and address of the person injured and shall state in ordinary language the cause of the injury and the date on which

the accident happened, and shall be served on the employer or upon any one or several employers, or upon any person directly responsible to the employer for the management of any branch of the trade or business in which the injured workman was employed.

(3) That notice may be served by delivering the same at, or sending it by registered post addressed to, the residence or any office or place of business of the person on whom it is to be served.

SCHEDULE I.

List of injuries deemed to result in permanent partial disablement.

Injury.	Percentage of loss of earning capacity.
Loss of right arm above or at the elbow	70
Loss of left arm above or at the elbow	60
Loss of right arm below the elbow	60
Loss of leg at or above the knee	60
Loss of left arm below the elbow	50
Loss of leg below the knee	50
Permanent total loss of hearing	50
Loss of one eye	30
Loss of thumb	25
Loss of all toes of one foot	20
Loss of one phalanx of thumb	10
Loss of index finger	10
Loss of great toe	10
Loss of any finger other than index finger	5

SCHEDULE III.

List of Occupational Disease.

Occupational Disease.	Employment.
Lead poisoning or its sequelae.	Any process involving the use of lead or its preparations or compounds.
Phosphorus poisoning or its sequelae.	Any process involving the use of phosphorus or its preparations or compounds.

Maxims of Equity.

(1) THERE IS NO WRONG WITHOUT A REMEDY. Ubi Jus, ibi remedium. This is the foundation of equity jurisprudence, it means that equity will not, by reason of a mere technical defect, let a wrong go without a remedy.

(2) HE WHO SEEKS EQUITY MUST DO EQUITY. That is, a person seeking the assistance of a court of equity must be prepared to do equity.

(3) HE WHO COMES TO EQUITY MUST COME WITH CLEAN HANDS. It means that a person seeking the aid of equity must not have been guilty of fraud or gross negligence.

(4) WHERE EQUITIES ARE EQUAL, LAW WILL PREVAIL. This means that where the defendant and the plaintiff are both equally entitled to the protection of

equity, and on no equitable grounds can one be preferred to the other, equity will do nothing and let the legal title have the day.

(5) "THE PRIOR IN TIME THE PRIOR IN TITLE." Qui prior est tempore, potior in jure est. This means that where the equities of the two parties are absolutely equal and there is no other ground on which one may be preferred to the other, then will priority in the time give the better title.

(6) DELAY DEFEATS EQUITY—That is, a party must not sleep over his rights. He must file his suit or petition for equitable relief within the period prescribed by the law of limitations.

(7) "EQUITY IS EQALITY" or "EQUITY DELIGHTS IN EQUALITY." That is, a court of equity will, where it can, put the parties to a transaction on the same equality, although the strict rules of common law may give one party an advantage over the other.

(8) EQUITY FOLLOWS THE LAW,—For instance, it adheres strictly to the rules of descent or inheritence, and to the rules of limitation.

(9) EQUITY LOOKS TO THE INTENTION AND NOT TO THE FORM—The intention of the parties guides a court of equity and not the exact words in which they express that intention. Therefore equity relieves against forefeitures and penalties.

(10) EQUITY REGARDS THAT AS DONE WHICH OUGHT TO HAVE BEEN DONE.—That is, if a contract

or an obligation is to be performed on a particular date and it is not, equity regards the contract or obligation to have been performed on the particular date, so far as the rights of parties interested in the contract or obligation is concerned.

(11) EQUITY IMPUTES AN INTENTION TO FULFIL AN OBLIGATION.—That is a party is under an obligation to do a certain thing and does something like it without expressly appropriating the thing done to his obligation, equity thinks that the thing was done in fulfilment of the obligation.

(12) EQUITY ACTS IN PERSONAM i. e. Equity enforces its behests by acting on the conscience of the person who is charged therewith. Though the property in dispute may be out of the jurisdiction of the court, equity will compel the defendant to carry out the decree of the court by constraining his person or seizing his property within the jurisdiction.

CHAPTER XXIII

Labour, Skill and Capital

We have hitherto considered the economics of engineering almost entirely from the engineeer's point of view. In this, the final chapter we purpose reconsidering the subject from the more general standpoint of the Indian citizen.

We do not think it possible that India will ever become as completly industrialized as Great Britain is, but there is little doubt that she is fated during the next two or three generations to traverse a good deal of the ground treversed by Great Britain during the time that has elapsed since the reign of Henry the Eighth.

He would be a good friend of India who would make a careful study of social conditions in England from Tudor times to the present day with the object of exhibiting to Indian Statesmen where in the transition, first to commercialism and then to commercial industrialism made for a general increase in the general welfare, and where in it did not.

The period of European history between 1453 and 1600 is commonly described by its historians as the "renaissance" (rebirth) because it saw a great quickening of intellectual activity among the literate classes; which is generally agreed to have been the result of the superposition of the Pagan and materialistic Greek learning upon the simple Catholicism of the middle ages. It is this intellectual revival, and the

resulting political developments that occupy the pages of history and obscure the equally important fact that for the common people the renaissance period was one of cumulative disaster from the destruction of the guilds similar to, but not so rigid as the Indian workers' castes to the arrival of the Trade Union which is a thing of yesterday.

In the year 1492 America was discovered, and one of the principal results during the following two centuries was a great inflation of European currencies by American gold. Spain and England up to the reign of Elizabeth imported little except treasure from the new world.

Now while we are not among those who would draw exact parallels between Occidental and Oriental history, we venture to suggest that India is in many ways at this present moment repeating something very like the renaissance at an accelerated pace. The philosophy of the West is, like the Greek and Roman from which it derives, essentially intellectual and materialistic, whereas the values to which the ancient Indian culture attaches most importance are essentially spiritual as were those of the Mediaeval church in Europe. And though India suffered no influx of Americam gold (probably, on the contrary, she made a substantial contribution to the European gold inflation) she has suffered and is suffering a great increase of manufactured credit which has, as we have seen the same results. A period of progressive inflation does

little good to any class, but for the servile class it is an unmitigated curse, as their wage always lags behind the rising tide of prices.

"Ill fares the land, to hastening ills a prey
Where wealth accumulates and men decay".

The poet means riches of course, not wealth. The men of a nation *are* its wealth.

The correspondence between the mediaeval guilds of Europe and the occupational castes of India is sufficiently close to make his familiarity with the latter a useful help to the Indian student in his efforts to understand the former. The zealous reformer of India who has no doubt that the caste system is entirely evil, especially: would learn a good deal that would surprise him if he made even a superficial study of what followed upon the virtual destruction of the Guilds under Henry the Eighth. It is not to be lightly forgotten that any sysem that lasts for centuries must have at least the merit of being a workable system. It is no doubt unfortunate that a large section of any community such as a guild or caste should be so rigidly confined within its own limits that an able man born within it and capable of rendering great service to, or even of leading the nation should be prevented from doing so. But such births are very rare especially if there is no marrying out of the caste.

On the other hand, the proposition that all men can, and ought to be equal and equally free is one of the most insulting lies ever invented by unscrupulous

politicians to flatter and mislead their ignorant dupes. A man can be free only to exert such capacity as he inherits, and it has so far pleased the Creator to send few men with great power and many men fitted only to serve them. The servile caste or any other caste cannot be abolished as long as the laws of heredity persist. It can only be disorganized and made more easily the victim of its oppressors. The Guildsman knew his work, and took a pride in it. It was he far more than the King who by his unity broke the tyrranous power of the Feudal System. Like that punkha walla who boasted that his primeval ancestor was a god who pulled a punkha for Indra, his work was his religion, and he rightly regarded his inherited abilties as in effect a mandate of his Creator, and the careful fulfilment of that command as the only honourable mode of existance.

The working class of the West remained unorganized and destitute of effective political power from the passing of the Guild until the appearance of the Trade Union in the second half of the nineteenth century. The Trade Union differs from the Guild or Caste as follows;–

It is not conceived as being in any way hereditary. Until the arrival of Mass Production it was recruited by a system of apprenticeship copied from the Guilds.

It is much more aggressive politically. It aims at the supreme power in the State and for some months

during the year 1924 there was a labour government of the British Empire

The master Workman was a member of the Guild, but the modern Employers' Federation is an organisation intirely separate from, and usually hostile to the Trade Union.

Finally a further segregation of capital and directing ability has followed upon the invention of the Limited Liability Company. The owner or capitalist is now or is now tending to be, a financier with little or no technical knowledge. It is he whose organisation is the Employers' Federation. Technical ability is organized in such societies as the Institutions of Civil, Mechanical, and Electrical Engineering; the so-called "Technical societies". The technical societies are not so much hostile to the Employers Federation and the Trade Union, both of which are merely endeavouring to get as large a share of the profits of industry as possible as they are indifferent to them.

We do not think that India will succeed in retracing her steps as an influential section of Indian opinion thinks she ought to do. We would rather suggest the careful study of Western institutions and of their history in a spirit of healthy scepticism, following neither those who would accept the conquest of material nature as conclusive evidence that those institutions are faultless, nor those who would condemn them utterly because of their spiritual sterility. The immense possibilities of human betterment inherent in the application of science

ot human affairs is a thing amply demonstrated which no people can afford to ignore.

At the same time it is quite easy to make out a plausible case for the suggestion that the pre-renaissance peasantry enjoyed a greater measure of real independence and liberty than does the mass production worker of these days, and was in many ways a more cultured class. And much the same may be said of the Indian ryott. Ability to read and write is by no means the whole of culture, and an engineer should need no convincing of the fact. Literateness alone is the mere phantom of culture. ESSENTIAL CULTURE is the skill to provide for some universal human need. The class which possesses such skill will always enjoy a considerable measure of independence and self-respect, no matter under what social system it has its being. It is good to know, but it is better to be able. Best of all is to use knowledge as the basis of increased power to satisfy the legitimate aspirations of all classes of mankind. Both the West and the East have so far failed in this. In the East knowledge has been the monopoly of a class that has failed to apply it to practical ends. Of the West on the other hand, it must be said that though knowledge is available to almost every man to the limit of his ability, and that it has been largely applied to the increase of wealth, yet utter carelessness has left the servile class to a large extent homeless on the roads of an indifferent world which has less and less use for it. The Indian Ryott may be robbed of a large proportion of the fruits of his

labour, but he is indispensible to the Nation's continued existence. He can stand upright in the consciousness that he is the Nation's bread winner.

It is far otherwise with the factory worker. It is no doubt true that he can read and write; that he can choose his own rulers, and that the community will in the last resort preserve him from absolute starvation. These are great advantages and every well wisher of India must desire the same for our own people. But we are not prepared to pay for them with the sacrifice of what we already enjoy. We do not think it necessary or desirable that large numbers of workmen should be idle and helpless during trade depressions that sometimes last for years. We do not consider it a matter if indifference that large numbers of shareholders of a great industry should know nothing of that industry, nor of those who work in it, and that their influence on it should be solely exerted to increase dividends. Nor could we rest satisfied with an industrial development that at every step makes large numbers of workers unnecessary to the community. It is not enough that they are preserved from starvation if at the same time they are robbed of that self-respect that comes only from effective co-operation in the World's work. And finally, though, as we have indicated, Mass Production methods are commercially and scientifically immeasurably superior to pre-existing methods, we consider that the price is too high if it means the reduction of the workers to mere automata.

This chapter has been re-written because it was at first a careful description of commercially successful Western organisations. For the reasons given above, however, we have decided that it is not our duty to represent these as models for exact imitation. Nor are we prepared to give any alternative on paper. No social or political problem ever has been or ever will be solved on paper. The problems inherent in the industrialisation or partial industrialisation of India will be solved by the generation at present in the schools by a process of trial and error. The Western learning is well worth having but it contains perhaps as much of warning as of encouragement. It contains many things worthy of imitation and not a few to be avoided like the plague. Moreover many Western writers and more Indians do not know which are which. So we come again to what we said in the preface: there is no substitute for thought. It has been our object throughout this book to arouse thought. We do not envisage our work as the providing of solutions. We see it rather as the clear formulation of a number of problems which our own generation has failed to solve, and at which we hope the new generation will be more successful. We, the old generation, would be glad to have our own successes such as they were, appreciated and it is possible that we have tended to magnify them. For that reason we conclude with the admonition; "Consider what we have said but take nothing for granted. Think for yourselves".

Agent's Responsibility 339
Annuities, 64
Assets, 59
Association, memorandum of, 328
Audit, 95
Banker's Drafts, 46
Balance Sheet, 96
Bank Book, 97
Bill of Exchange, 42, 60
Bill of Lading, 354
Bill Book, 99
Boiler, choice of 149
Bolier Act 354
Castes and Guilds, 379
Cheques, 6
Cheque Book, 97
Contract Act, 332
Company Formation, 327
Compensation, Act (Workmen's) 361
Commodity Money, 2
Credits, 70, 263
Credit Book, 99
Current Account, 59
Debit, 70
Deposit Account, 59
Depreciation, Estimation of, 200
Depreciation, 189, 233
Double Entry, 69
Engine, oil, 134
Engine, Gas, ,,
Engine, Steam, 132
Engineer, superintending selection of 175
Equity, 324, 374
Exchange, rate of, 43
Factories Act 348
Fuel Cost, 146
Factor, Load, 179
Generator cost, 143
Gold, 21
Guilt Edged Investment, 29
Guilds and Castes, 379
Hydro-electric Plant, 137
Inconvertible currency, 5
Indent, 49
Invoice. 99
Invoice, 99
Jigs, 270
Journal, 96
Labour, 111
Legal Tender, 6
Load Curve, 168

Limited Liability, 31, 325
Liabilties, 59
Life, Duration of useful, 197
Limits, 268
Market Analysis, 163
Money Orders, 46
Mortgages, 61
Negotiable Instrnment, 52
Obsolescence, 191
Order Book 99
Partnership, 30, 325
Petty Cash, 104
Piece Work, 271
Plan, Building, 121
Presentation, 165
Prices, 2. 253
Private Company, 40. 325
Profit & Loss Account, 94
Quotation, 49
Railway Receipt. 52
Shares, 34
Store Book, 106
Space, Required by Factory Act, 119
Space, Floor, 140
,, , Boiler, 153
Standard Forms, 223
Specification, 49
Ship, 50
Stock Exchange, 36
,, , Visible, 247
,. Book, 245
Store-keeper's Book' 24
Tariffs, for Electric Power, 184
Task System, 272
Tenders. 280
Token Money, 4
Tool Room, 247
Transport, Cost of, 113
Trade Union, 380
Turbine, Steam, 132
Units, Selection of, 172
Ventilation, 127
Voucher, 93

